REVIEW OF THE SPACE PROGRAM

HEARINGS

BEFORE THE

COMMITTEE ON SCIENCE AND ASTRONAUTICS U.S. HOUSE OF REPRESENTATIVES

EIGHTY-SIXTH CONGRESS

SECOND SESSION

FEBRUARY 8, 9, 15, 16, 17, AND 18, 1960

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MONDAY, FEBRUARY 8, 1960

House of Representatives,
Committee on Science and Astronautics,
Washington, D.C.

The committee met at 10 a.m., Hon. Overton Brooks (chairman) presiding.

The Chairman. The committee will come to order. We will give the photographers just a moment, time to finish their picture taking before we go into session.

Mr. Beresford, do you have a report you want to make in reference to a briefing Wednesday afternoon?

Mr. Beresford. I have an announcement, Mr. Chairman, that we are trying to arrange for a briefing to be given on Tuesday afternoon at 2 p.m.

The Chairman. Wait, I want everyone to hear.

Would you stand up, Mr. Beresford, and talk a little louder, because you don't have the microphone.

Mr. Beresford. We are trying to arrange for a briefing to be given tomorrow afternoon at 2 by representatives of the Navy and the Goodyear Co. on Project Wagmight for such members of the committee as can attend.

The Chairman. Is it going to be here?

Mr. Beresford. Here, yes, sir.

The Chairman. Well, we can all bear that in mind. So we will finish early enough in order to have that briefing afterward. All of the members of the committee that wish to remain can do so for the briefing.

Those that have other engagements, we will understand if they can't be present.

Now, is Captain Ducander of the Navy Reserve here?

Mr. Ducander. Yes, sir.

The Chairman. We are proud to announce that Mr. Ducander is now a captain in the Navy Reserve.

Mr. Ducander. Also Mr. Fulton.

The Chairman. I want to announce that in the presence of the Secretary.

Also Mr. Fulton is Captain Fulton.

We are very happy to have all of this brass around us here. [Laughter.]

Mr. Fulton. If we act too favorable to our superiors this morning, you will know the reason.

The Chairman. Mr. Secretary and Admiral Burke, it is customary in this committee, in these hearings, to swear in all of the witnesses. You and the Admiral and who else will support you there?

Secretary FRANKE. Assistant Secretary Wakelin and Admiral Hayward.

The CHAIRMAN. We would like to swear everyone in at one time. Do you and each of you swear that any testimony that you will give to the committee in matters now under consideration will be the truth, the whole truth and nothing but the truth, so help you, God?

Secretary FRANKE. Yes, sir.

Admiral BURKE. Yes, sir.

Mr. WAKELIN. Yes, sir.

Admiral HAYWARD. Yes, sir.

Mr. FULTON. Will you yield for another promotion?

The CHAIRMAN. We can't take too many promotions.

Mr. FULTON. This is your own good self. In the Air Force and Space Digest of February 1960, on page 50 they have a picture of MAAG Gen. James Fry, Charles Ducander, counsel to the Brooks Committee, Colonel Sims, gathered for conference on the European defense problems in Naples and they list here as the committee chairman, Senator Brooks.

The CHAIRMAN. The gentleman is out of order now.

You will have me in trouble with the other body.

This morning we are happy to have the Secretary of the Navy here. There are so many recent Navy developments that need our attention and our understanding, that we look forward especially to this event this morning, having the Secretary.

Mr. Secretary, you have a prepared statement, I believe?

Secretary FRANKE. Yes, Mr. Chairman.

The CHAIRMAN. We will be pleased if you will proceed with the statement.

Secretary FRANKE. Thank you.

STATEMENT OF HON. WILLIAM B. FRANKE, SECRETARY OF THE NAVY

Mr. Chairman and members of the committee, it is a pleasure and privilege to be with you this morning to summarize the Navy's views concerning the national space effort, and to introduce to you the Navy witnesses who will tell you of the effort that the Navy Department is making in this field.

First of all, I would like to emphasize that the Navy shares completely the interest and concern of this committee in our Nation's progress in space research and exploration. The Navy witnesses who appear before you will do everything possible to be helpful to you in the work you are doing. These witnesses will be—incidentally, I would like to add Admiral Burke in here, because I didn't know he was going to be here this morning and neither did he, as a matter of fact, know whether he had a conflict of committees or not:

Admiral Burke; Dr. James H. Wakelin, Assistant Secretary of the Navy for Research and Development; Vice Adm. R. B. Pirie, Deputy Chief of Naval Operations for Air; Vice Adm. J. T. Hayward, Deputy Chief of Naval Operations for Development; Rear Adm. W. F. Raborn, Director Special Projects, Bureau of Naval Weapons; Rear Adm. T. F. Connolly, Assistant Chief for Pacific Missile Range and Astronautics, Bureau of Naval Weapons.

They will tell you in some detail of the work that the Navy Department is doing. I believe that I can best further your efforts by limiting myself to a few comments on the Navy's overall policy in approaching space matters.

The Congress has established the National Aeronautics and Space Administration (NASA) to spearhead the Nation's civil effort in the scientific exploration of space. This in my opinion was highly desirable and will simplify the Government's task in mobilizing our country's civilian scientific and technical manpower to further our knowledge of and accomplishments in space.

The military task before us is, of course, closely related to this effort and must be coordinated with it, but the military task presents distinct problems and challenges of its own. We in the military services must strive to assure that the national security is not endangered through the space activities of any potential enemy and that our own military forces are able and ready to seize the opportunities offered by space exploration to strengthen our Nation's defense.

I would like to emphasize that the Navy's efforts in space exploitation and use are directed first and always to improving our ability to carry out the recognized missions which have been assigned to the Navy.

Each year that I am with the Navy Department I become more and more aware of the scale, the scope, and the importance of the Navy's job in maintaining and improving America's seapower and the strength that seapower gives to us as the world's greatest maritime nation.

At first glance, it may seem out of place to discuss such a traditional role with this committee, but our seapower has never been more important and is relevant to today's discussion. Our links to our allies, all of our operations in cold and limited wars, and the invaluable deterrent to be created by roving missile submarines are all essential to our national safety.

Maintaining this seapower is the Navy's first and great task. Our interest in space operations and the large investment we have already made in space research is aimed at using space to do our assigned job better and more efficiently. If we believe that we can navigate our ships more accurately through our space vehicles or communicate more quickly and more surely, then we will seek to build that capability.

The Navy is certain, as I am sure all of you are certain, that there is more than enough work that needs to be done in space research for all the civil and military groups interested in the field. Certainly each military service has a contribution to make. Today each service has primary responsibility for a specific type of warfare and as a result, each service has developed specialized equipment.

For example, each needs specialized types of aircraft to meet its own peculiar requirements. We in the Navy believe that the same specialized requirements will prove true of space vehicles.

For the years immediately before us, however, our need in space work is knowledge, and that means research work—hard research work from many different angles and toward many objectives. This research work should, and will, I believe, be conducted with the free interchange of information and findings between services and between departments which the Navy has always sought to foster.

It is a pleasure for me to be here this morning. I hope that you will call upon the Department of the Navy to help you in every way possible as your study continues.

The CHAIRMAN. Mr. Secretary, a very fine statement. I think it is very fair. It has a cooperative touch to it, and with that sort of attitude, I know you will get along with the other departments.

Would you like, Mr. Secretary, for us to proceed to hear from the admiral, or would you like for us to ask you questions and then release you to go back to your duties? What is your pleasure?

Secretary FRANKE. Dr. Wakelin has a statement to make. I think Admiral Burke does not have one—you have one? I am sorry.

The CHAIRMAN. The admiral has one. I think we have copies of it.

Secretary FRANKE. And Dr. Wakelin also has one. Mr. Chairman, I would like to suggest, it would seem to me it would be good for the committee to hear the three statements.

The CHAIRMAN. All right.

Secretary FRANKE. And I am prepared to stay here.

The CHAIRMAN. All right. We will hear the three statements. Here is one by Dr. Wakelin. Does everybody have a copy of that?

We will hear then the Assistant Secretary of the Navy for Research and Development, the Honorable James H. Wakelin, Jr.

STATEMENT OF HON. JAMES H. WAKELIN, JR., ASSISTANT SECRETARY OF THE NAVY, RESEARCH AND DEVELOPMENT

Dr. WAKELIN. Mr. Chairman, gentlemen: It is an honor for me to have the opportunity to talk with you gentlemen this morning. I sincerely hope that I and the officers who will follow me can provide you with information and assistance that will help you in the work before you.

Mr. Franke has summarized for you the Navy's overall policy on space efforts. I would like to tell you a little more about how we in the Navy Department are approaching research in space technology.

Like Mr. Franke, I would like to emphasize that the Navy is and always has been a specialized service with specialized tasks and duties to carry out. Our work centers on the place of the sea in our national security and in our way of life. For the conceivable future adequate strength in the ocean areas of the world will continue to be as vital in our national scheme of things as it is today.

But through the years the Navy's research efforts in seeking better ways to do its traditional job have led to discoveries and inventions that have far wider applications for the Nation as a whole. In the last century the Naval Observatory was set up to improve the quality of our navigation.

This institution has played a key role in the growth of the Nation's proficiency in astronomy and has set a standard for precision, particularly in the field of timing, which is recognized throughout the world.

The intensive work which Dr. Robert Page and others at the Naval Research Laboratory put in on the early development of radar vastly improved the fighting ability of the fleet, but the results of their ef-

forts are now seen in many phases of commercial aviation and shipping. Modern radio astronomy which opened to view new distances in outer space owes much to the early work on radio and its uses carried out at the Naval Research Laboratory and other naval facilities.

Our research work in the space age is still directed to our task. The Navy has a job to do and we are seeking better ways to do it. To increase our knowledge of the upper atmosphere and weather conditions we began exploratory work with high altitude balloons some 10 years ago. This work is continuing today and has been fruitful throughout. Some of you may have noticed press reports of a balloon research experiment conducted from the carrier *Valley Forge* only last month. The activities you will hear about from the officers who follow me are part of an overall effort which already has a commendable history and which, as experience accumulates, has an ever greater potential for the Navy and for the Nation's benefit.

In short, the Navy's program to develop its knowledge of and capability in space is a natural growth of our never ceasing work to improve America's capability to launch power from the sea.

Now, I would like to tell you very briefly about the Navy's organization for work on space matters.

First, there is my office—that of the Assistant Secretary of the Navy for Research and Development. This is a new office created on February 6, 1959. As Assistant Secretary, I am responsible for the control and management of all phases of the Navy's research and development work. I sincerely believe that the existence of this office has permitted a real improvement in the coordination and focusing of research work on the pressing problems that confront us. Another important aspect of my job is the coordination of the Navy's efforts with those of the other services and other agencies in the Government. I have excellent working relations with my colleagues in the other services and I am satisfied that constructive cooperation among us is still improving.

Within the Office of the Chief of Naval Operations there have been two recent changes which facilitate efficient management of the Navy's work on space. A new post of Deputy Chief of Naval Operations, Development, was created last year. This post is ably filled by Vice Adm. John T. Hayward who, among his other duties, coordinates development work in astronautics. He will speak to you on this area in greater detail.

The Deputy Chief of Naval Operations for Air, Vice Adm. Robert B. Pirie, who will also testify, has created within his organization an Astronautics Operations Division with responsibility for operational phases of space application and space flight.

As you know, during the last year the Bureaus of Aeronautics and Ordnance were combined into a single Bureau of Naval Weapons, since it was felt that a single organization could better meet the demands of modern technology and modern warfare. This Bureau has an Assistant Director for Astronautics whose responsibility it is to oversee the astronautics work in the Bureau's laboratories and test stations, and in contracts with private firms. This officer is also responsible for the technical and management control of the Pacific Missile Range.

In 1946 the Office of Naval Research was created by congressional action, and, while this hardly constitutes a recent change in Navy

organization, it is worth mentioning this morning, for the Office of Naval Research in its relatively short life has built up a national reputation for imaginative and competent research in virtually all fields of science. This office has repeatedly demonstrated that it is one of the Nation's major assets in meeting new and demanding technical challenges.

These are the mechanisms whereby the Navy guides and coordinates a large and broad program of scientific and technical advancement. The laboratories of the Navy explore problems in the fields as diverse as weather, photography, and medicine. They have already made major contributions in our initial steps toward the conquest of space. Their potential is great. The Navy is determined to move forward rapidly in meeting its own urgent and evident requirements. We will cooperate to the fullest with the other elements of Government working in this field and we will do everything we can to advance the Nation's overall space effort.

(The biographies are as follows:)

Biography of William Birrell Franke

Appointed by President Eisenhower to serve as Secretary of the Navy, the nomination of William B. Franke, of New York City, was confirmed by the Senate and he took the oath of office on June 8, 1959. Prior to his appointment, Mr. Franke served as Assistant Secretary of the Navy (Financial Management) from October 1954 until April 1957, and as Under Secretary of the Navy from April 1957 until June 1959.

William Birrell Franke was born in Troy, N.Y., on April 15, 1894. He has resided in New York State since his birth. In Washington, D.C., Mr. and Mrs. Franke reside at 5016 Loughboro Road NW. They have a home in Rutland, Vt.

He attended local schools in Troy, N.Y., and was graduated from Pace Institute of Accountancy in New York City.

Prior to graduation from Pace Institute, Mr. Franke was employed by Cluett, Peabody & Co., of New York, and by Naramore, Niles & Co., of Rochester, N.Y., until 1928, when he formed his own accounting firm of Franke, Hannon & Withey, of New York, and became the senior partner. In 1924 he became a member of the American Institute of Accountants and also during that year, was received into the New York State Society of Certified Public Accountants. He holds an honorary degree of doctor of science from the University of Louisville, which was bestowed in 1948 and the honorary degree of doctor of laws from Pace College in June 1955.

From 1948 to 1951, Mr. Franke was a member of the U.S. Army Controllers Civilian Panel, Washington, D.C. He was special assistant to the Secretary of Defense in 1951–52. In 1951 Mr. Franke was given the Patriotic Civilian Commendation by the U.S. Army, and in 1952 the Distinguished Service Award by the Department of Defense.

In addition to being the senior partner in his own firm, Mr. Franke was associated with a number of other firms in various capacities which included positions as chairman of the boards of John Simmons Co., Inc., and General Shale Products Corp., and as director of the Carolina, Clinchfield & Ohio Railway Co.

Mr. Franke is a member of the Union League Club, of New York City; the Army-Navy Club and the Chevy Chase Club of Washington, D.C.; and the Rutland Country Club, of Rutland, Vt.

Mr. Franke is married to the former Bertha Irene Reedy (formerly of Schenectady, N.Y.). They have three children: Phyllis (Mrs. Harding H. Fowler), Anne (Mrs. John Anthony Ulinski, Jr.), and Patricia (Mrs. W. Sherman Kouns).

August 25, 1959.

Biography of James H. Wakelin

James H. Wakelin was born in Holyoke, Mass., on May 6, 1911. He attended the public schools in Holyoke, graduating from high school in 1928. He received

an A.B. degree in physics from Dartmouth College in 1932. During 1932–34 he attended Cambridge University, Cambridge, England, where he was granted a B.A. degree in the natural sciences in 1934 and an M.A. degree in 1939. Dr. Wakelin received his Ph. D. degree in physics from Yale University in 1940, where he specialized in the field of ferromagnetism. During 1939–43 Dr. Wakelin was a senior physicist in the Physical Research Department of the B. F. Goodrich Co., Akron, Ohio. His work there was concerned with the structure and physical properties of natural and synthetic rubber, and with X-ray diffraction and electron microscope studies of high polymers.

From 1943 to 1945 he was ordnance staff officer to the Coordinator of Research and Development, Navy Department, Washington, D.C. During 1945–46, as a lieutenant commander, USNR, he was head of the Chemistry, Mathematics, and Mechanics and Materials Sections of the Planning Division, Office of Research and Inventions, and was active in the planning and organization of the Navy's Office of Naval Research. Following World War II, Dr. Wakelin joined a group of former Navy research scientists in the establishment of Engineering Research Associates, Inc., of Washington, D.C., and St. Paul, Minn., and held the position of director of research.

While with this company, he was also director of the field survey group of ONR Project Squid under contract to Princeton University. In 1948 he became associate director of research of the Textile Research Institute in Princeton, and in June 1951 was appointed director of research of the institute, serving in this capacity for 3 years. In 1954 Dr. Wakelin established his own consulting business in Princeton and has been a consultant on research planning and organization to the lamp division, General Electric Co., Cleveland, Ohio; Stanford Research Institute, Palo Alto, Calif.; American Radiator and Standard Sanitary Corp., New York City; J. P. Stevens & Co., Inc., New York City; Frenchtown Porcelain Co. and Star Porcelain Co. of Trenton, N.J. He was one of the founders in 1954 of Chesapeake Instrument Corp., Shadyside, Md., established to conduct research and development for the Navy in the fields of underwater sound and acoustic devices. He has been a vice president and consultant of that company. During this period he was also a research associate on the staff of Textile Research Institute working on the structure and physical properties of high polymers under a program sponsored by the Office of Naval Research.

Dr. and Mrs. Wakelin, the former Margaret Cushing Smith of Concord, Mass., have lived in Lawrence, N.J., for the past 10 years. They have three boys: James H. III and Alan B., who attend the Lawrenceville School, and David, a student at the Princeton Country Day School. The Wakelins have been active with the Cub Scouts and the parent-teacher association in Lawrenceville and with the American Red Cross in Princeton. Dr. Wakelin served as president of the Nassau Club of Princeton in 1955 and as a member of the board of trustees 1956–59; he is also vice president of the fathers' association of the Lawrenceville School. Mrs. Wakelin is active as a volunteer with the Princeton Hospital where she is now chairman of the hospital aid committee. The family's recreational hobbies include golf and sailing and they spend their summer vacations on Pickering Island in Penobscot Bay, Maine.

Dr. Wakelin is a member of Sigma Xi, the American Physical Society, American Association for the Advancement of Science, the Association for Computing Machinery, the American Crystallographic Society, Textile Research Institute, the Textile Institute of Great Britain, and is a contributor of scientific papers to the Journal of Applied Physics, the industrial and engineering chemistry and textile research journal in the field of high polymer physics. He is a coauthor, with C. B. Tompkins and W. W. Stifler, Jr., of "High-Speed Computing Devices," published by McGraw-Hill Book Co. in 1950.

The CHAIRMAN. Thank you very much, Dr. Wakelin. It is interesting to note from your statement that the Office of Assistant Secretary of the Navy in charge of this work is about 1 week younger than is this committee, itself; created about the same time.

Now, we have Adm. Arleigh A. Burke, Chief of Naval Operations.

Admiral BURKE. Thank you, Mr. Chairman, and I want to apologize for not having my statement written out, but I didn't know I was going to appear. It was written yesterday, sir.

The CHAIRMAN. Well, you will deliver it with your usual emphasis and we will understand it all right, I am sure.

Admiral BURKE. Thank you, sir.

STATEMENT OF ADM. ARLEIGH A. BURKE, CHIEF OF NAVAL OPERATIONS

Admiral BURKE. Mr. Chairman, gentlemen, I particularly welcome this opportunity to reaffirm the views that have already been stated regarding the Navy's role in the space age. I should also like to emphasize, as much as I know how, that the field of space and astronautics is one in which the Navy shares a great interest, with the other military services and civilian agencies. Space is being investigated for scientific, political, and military purposes. From its long experience in basic research, and particularly space exploration, the Navy has concluded that use of space techniques can substantially contribute to the execution of its assigned tasks and missions. It also recognizes that use of these techniques by an unfriendly nation might seriously impede the successful functioning of naval forces some day in the future. Thus, the space activities of the Navy are directed toward accomplishment of these two ends—the use of space, and protection against the use of space by potential enemies.

The rate of our space exploitation is carefully planned to meet the demands of the present and the future. The Navy's space program is not an internal endeavor, but consists of support to the national effort, coordination with the other military services in the military space program, and pursuit of these areas peculiar to naval needs.

In the fields of space and astronautics, the Navy has stated as immediate objectives in 1961 the attainment of improved navigation and communications by use of artificial Earth satellites. We have additional requirements for satellites to perform surveillance, weather observations, and surveying, plus systems to afford detection of space vehicles. It is recognized that some of these requirements may not be met in the near future, although their accomplishment would represent improvements of great value.

Because of naval interest in navigational systems, the Navy was asked to develop the navigational satellite for military use. The satellite detection system, developed by the Navy under Defense sponsorship, provides satellite information for all the military services and the scientific community as well. Similarly, the development of other space systems by the Army or Air Force will help to satisfy naval requirements. Each service, of course, must adapt a basic system to its particular needs and must execute and fund its operations.

The space programs now under development are considered by the Navy as necessary steps in the evolution of systems to be applied tactically in future naval operations. Improvement of components and greater propellant efficiency may allow sea and air launch of satellites at low cost. These systems will provide greater flexibility of operations with increased security and speed.

The Navy's space program provides a logical and efficient transition of current space projects from the research to the operational stage. It also pursues the specialized projects assigned by the Department

of Defense or NASA and supplies the results to all designated users. Participation in space programs will enable the Navy to derive maximum advantage for its own purposes from space activities conducted for the benefit of all services. I believe that the presentations of the various Navy witnesses will give you a clear picture of the importance to the Nation of the Navy's participation in space.

Thank you, Mr. Chairman.

The CHAIRMAN. Thank you very much, Admiral, for a fine statement.

Now, at this point we can proceed with the questions. Mr. McCormack?

Mr. McCORMACK. How is your relationship with NASA?

Secretary FRANKE. Our relationship with NASA is fine.

Mr. McCORMACK. Of course, NASA is a new agency and has to establish a climate. We should realize that fact, and I suppose that is included in your answer.

Secretary FRANKE. Yes, it is, Mr. McCormack.

Mr. McCORMACK. I would like to get your views on section 309 of H.R. 9675. Have you seen it, Mr. Secretary?

Secretary FRANKE. Yes, sir, I have.

Mr. McCORMACK. In the first place, when did the Navy first know about this bill being introduced?

Secretary FRANKE. Well, we did not see the bill before it was introduced, but I believe Secretary Wakelin had some informal conferences and perhaps he should explain.

Mr. McCORMACK. Informal conferences would be consultation?

Dr. WAKELIN. Yes, with Mr. Horner and Dr. Glennan, sir.

Mr. McCORMACK. How long before the introduction of the bill did you have this conference?

Dr. WAKELIN. In the order of the middle of December.

Mr. McCORMACK. So you have been acquainted with the development and the thinking?

Dr. WAKELIN. In a very general way, sir, yes.

Mr. McCORMACK. Well, concentrating on 309, you are well acquainted with it, I assume?

Dr. WAKELIN. Yes, sir.

Mr. McCORMACK. And having in mind what the Secretary said, that the military services must strive to assure that the national security is not endangered through space activities of any potential enemy and that our own military forces must be able and ready to seize the opportunities offered by space exploration to strengthen our Nation's defenses, also this further statement by Admiral Burke that each service must establish a basic space system for its own use, would you care to comment on section 309 as to whether it will restrict any of those functions?

Secretary FRANKE. Mr. McCormack, I don't think so. Of course, this gives the Defense Department the right to undertake these activities. And what Navy does would, of course, be determined by our conferences and our association with the Secretary of Defense.

Mr. McCORMACK. Nothing in this act shall preclude the Department of Defense from undertaking such activities involving the utilization of space. How do you construe the word "utilization"? Have the brains of the Navy Department leveled on that yet?

Secretary FRANKE. I think that means any developments that take place either in any military service or in NASA——

Mr. McCORMACK. You say——

Secretary FRANKE. Would be available.

Mr. McCORMACK. You say development, would that go into research aspects?

Secretary FRANKE. Yes, I think so, because the latter part of that paragraph says including the development of weapons systems utilizing space vehicles and the conduct of supporting research connected therewith.

Mr. McCORMACK. What is supporting research?

Secretary FRANKE. I think any research——

Mr. McCORMACK. The executive branch levels on these words. We found that out on the word "except," which has been construed somewhat differently than the select committee of which I was chairman intended. I know some of the advocates in the Defense Department stretched the interpretation of that word, certainly not as intended by the committee of which I was chairman. I think I can speak for both sides on that.

Mr. FULTON. Correct, sir.

Mr. McCORMACK. What is your construction of "supporting research"?

Secretary FRANKE. I don't read this as being restrictive. It seems to me that any research that we might do or NASA might do would be determined by the relationship between NASA and the Defense Department. And that at that point a decision would be made as to who is going to do it, plus the fact that each side of this picture should have available to it whatever is done by the other side.

Mr. McCORMACK. Well, now I am a strong defender of NASA in its sphere, but I recognize the world of today and the importance of preservation and our military services. We just got to be practical. Does this mean that you or your representatives have got to get an agreement that you have jurisdiction over things like navigational satellites?

Secretary FRANKE. Well, I think that originally the responsibility for the development of a navigational satellite, for example, would have to be determined. A determination would be made whether this would be NASA or the Defense Department.

If it were then agreed it should be the Defense Department's responsibility, the Secretary of Defense would have to determine which service could best perform this task.

Mr. McCORMACK. If the Defense Department makes that decision—did you say that?

Secretary FRANKE. I think it is done in cooperation and coordination with NASA.

Mr. McCORMACK. That is different from what you said.

Secretary FRANKE. I didn't mean it to be different.

Mr. McCORMACK. I am not here to cross-examine you. I am trying to get information to perform what I consider to be my duty. I will be frank with you, and I have stated to the world that I think we have got to resolve any twilight decisions in favor of the military in the world of today, questions of jurisdiction, that is.

Go ahead. You say now that you agree among yourselves, but then you go over and consult with NASA, is that right?

Secretary FRANKE. That is right.

Mr. McCORMACK. Well, what effect does that have? Does that mean that NASA has a veto?

Secretary FRANKE. Well, if there were a major problem and the be decided without any great difficulty. Now, on any major project——

Mr. McCORMACK. I won't disagree with that. There will be no great difficulty if everyone has an understanding mind. Go ahead.

Secretary FRANKE. Well, if there were a major problem and the Defense Department and NASA could not agree, then, of course, the President would have to make the decision as to who was to sponsor the project. But in most of these we have close association with NASA, we have liaison people with NASA and I don't anticipate great difficulty.

Mr. McCORMACK. So speaking for the Navy Department, you approve of the language as written in section 309?

Secretary FRANKE. Yes, sir.

Mr. McCORMACK. The Air Force approved in principle—they are going to look it over more carefully and might make some suggestions. I think the Army is probably the same way. But you approve absolutely of the language used?

Secretary FRANKE. Yes; I think so. I noticed that the Air Force in testifying said there might be changes in individual words here and there, and maybe this is true, but in general, I think this is a good act.

Mr. McCORMACK. Why don't we ask Admiral Hayward, if it is not going to embarrass him. I don't want any questions asked embarrassing a man in the uniform. I don't want that misunderstood. I will ask questions about the defenses of our country, but there are certain technical delicate situations. Admiral Hayward, what are your views on section 309?

Admiral HAYWARD. I am not a lawyer, but I read supporting research as things we are doing all the time.

Mr. McCORMACK. Wouldn't it be much better if you had the word "supporting" stricken out and said "the conduct of research connected therewith"? That is greater, it seems to me. "Supporting," it seems to me, might be a word of limitation.

Admiral HAYWARD. Well, we use it in the budgetary terms as applied and supporting research. As I say, I am not a lawyer, but I feel that this gives us the right to do any research and development that we need in this area.

Now, I don't see any limitation on that particular section there.

Mr. McCORMACK. Mr. Secretary, there would be no objections from your angle to striking out the word "supporting", would there?

Secretary FRANKE. I wouldn't think so.

Mr. McCORMACK. All right, that is all.

The CHAIRMAN. Mr. Fulton.

Mr. FULTON. We are glad to have you here and I am glad to have the interest of the Navy in space. As a matter of fact, we have heard from Admiral Hayward quite a bit and have been briefed several times under Navy auspices on various projects and it has been very informative. I would like to ask shortly about the navigation satellite. Would you people like to have that Transit project assigned to you by ARPA?

Secretary FRANKE. The answer is "Yes."

Mr. FULTON. Now about the Notus, communications satellite, are you interested in that?

Admiral HAYWARD. We are interested in it, but I feel strongly the way was decided originally to the Army, the Army should get on it.

Mr. FULTON. Is there any dispute on the assignments of anything like Midas, Samos, or any kind of that project? Is there any question on where it should go in the Department of Defense or should it just be held by the ARPA people? I am trying to get the allocation.

Admiral BURKE. Yes, sir, there is always question about these projects—take the Transit project which is a Navy-assigned project. We are going to put into that satellite equipment which will assist the other services. They will assist us in developing that equipment and inform us of their requirements. Now, that is true in all the other satellites. In communications satellites, for example, our requirements are somewhat different from those of the Army, because we will want to read these satellites out at sea from ships. So there is always a good deal of close cooperation required in order to get the material that is needed by all the services in each satellite.

Mr. FULTON. And you would say that the assignment to a particular service is not quite as important as some people are making it, because close cooperation makes it a joint effort anyhow?

Admiral BURKE. Well, the service with the majority of the experience in that particular area, or the service with the greatest requirements in that area, and sometimes they are not exactly the same, should have the assignment of the satellite.

Mr. FULTON. Do you put the Midas project at a high priority?

Admiral BURKE. Yes, sir, the Midas project is at a high priority. Yes, sir, I do. It is further away than Transit, but all of these experimental projects which will help us do our job on the face of the earth better are important, sir.

Mr. FULTON. And the Samos project, then, photographing and electronic processes?

Admiral BURKE. Yes, sir, that is further away, probably than——

Mr. FULTON. But you think that is high priority?

Admiral BURKE. Yes, sir, it will be.

Mr. FULTON. Could I ask you then, in conclusion on one point and that is the Project Wagmight. That is the foldable low level aircraft?

Admiral BURKE. Yes, sir.

Mr. FULTON. First, does the Navy have an interest in it?

Admiral BURKE. Yes, sir.

Mr. FULTON. Secondly, does the Navy have a strategic—an area need?

Admiral BURKE. Yes, sir. We have a great interest in that project. As you know, Wagmight is an inflatable device and we have a great interest in it.

However, in examining the problem, the material that has to be carried in Wagmight is noncompressible. I mean by that you have to put a lot of electronic equipment in this vehicle. And that equipment was noncompressible. The equipment that had to be put into

it was so big in proportion to the vehicle, itself, that it looked like use of Wagmight was not going to be feasible.

Mr. FULTON. Would it be feasible to cargo ships or submarines where space is important?

Admiral BURKE. Yes, it would be, but you can't compress it nearly as much as we thought we would be able to. We are still interested in it, but we have to do a lot more miniaturizing before that will be a feasible project, sir.

Mr. FULTON. You do have an interest that research and development are formed on it, whether by you or by private enterprise, is that right?

Admiral BURKE. That is correct, sir.

Mr. FULTON. And you do have a need of a vehicle or some sort of a project of this kind where you can mass produce it, do it quickly, at low level flight, possibly at 2,000 foot altitude and maybe 400 knots speed? Could we ask Admiral Hayward that?

Admiral BURKE. All right.

Admiral HAYWARD. Mr. Fulton, there has been a lot of confusion on this program.

The actual proposal that was turned down was one that was submitted by Goodyear that had to do with getting aerodynamic data on an airfoil. The real advantage of this particular material might be to use it structurally in a lot of places, but to try and go from zero, from nothing, really, and make a foldable jet missile or airplane was just too much to expect. You can't do it technically. You might use this material in many places and our interest in it is: Can we substitute this material for metal, structurally?

Mr. FULTON. But you are interested?

Admiral HAYWARD. Yes, sir, we are interested in the material as such, but to say we are interested in going right now to a complete folded jet airplane of this 400-knot configuration is wrong. This is where we are all the time getting ourselves in trouble by trying to invent on schedule again.

Mr FULTON. Do you have any funds under you that would be available for such a research and development project?

Admiral HAYWARD. We have funds on the materials, always, Mr. Fulton. We would investigate it structurally as to what you actually could expect from it.

Mr. FULTON. Is there any program now in operation on it or programed?

Admiral HAYWARD. There is not at the moment; no, sir.

Well, there is the fact that we actually have an inflatable airplane as you probably know, but this is at a much lower level structurally than the Wagmight proposal.

The CHAIRMAN. That is a matter we are going to be briefed on tomorrow.

Admiral HAYWARD. Yes, sir, it is.

Mr. FULTON. That is all.

The CHAIRMAN. By the way, too, the Admiral is a witness for tomorrow.

Admiral HAYWARD. Yes, sir.

The CHAIRMAN. You can use him today, but you will be crowding the Secretary, and the Assistant Secretary.

Mr. FULTON. Thank you very much, I appreciate it.

The CHAIRMAN. Mr. Miller?

Mr. MILLER. Mr. Secretary, talking not about theoretical things, I am very much concerned with the present, where we stand right now. How far, if you can tell me, do you think Polaris is away from being operational, or is that classified?

Secretary FRANKE. It is very close to being operational, we believe. We will have some tests within the next few months, probably by about July, which, if successful, will pretty well prove out this program, although we do not anticipate any difficulties.

Mr. MILLER. In other words, your last firings of Polaris have all been successful?

Secretary FRANKE. They have all been successful, five in a row.

Mr. MILLER. Five in a row, because after all, when we talk about closing this gap, to me Polaris is one of the things you are going to use to close this gap and it is the "Sunday punch" that we have got to get on with right now. I am very happy to get this.

Incidentally, I want to congratulate the Office of Naval Research. I think you have brought Polaris along and while you brought it along, you have had the courage to get it to the point where we could put it into production. I feel it is one of the great defensive weapons of this generation. Maybe there will be some more things in the future, but right now, we are depending a great deal on Polaris.

How far, or is that classified, do you think that you can fire it? We have heard——

Admiral BURKE. This missile, as it now stands, will fire about 1,200 miles.

Mr. MILLER. 1,200?

Admiral BURKE. Yes, sir. Within a couple of years it will fire 1,500 miles. We anticipate no difficulty in that at all.

Mr. MILLER. 1,200 miles gives us a good range, that is within 10 percent of what we thought it would do when we first began to talk about it.

Admiral BURKE. Yes, sir.

Mr. MILLER. I want to congratulate you, too, on Sidewinder. This is something that is gone and forgotten. It was developed inhouse in the Navy and I think it is a great weapon. It stopped the Chinese Communists cold last time and they haven't seen fit to want to challenge it with all of the developments that have supposed to have taken place behind the Iron Curtain since. You have also been doing a lot of work down at the South Pole and the Arctic. I believe this is in the field of magnetism and gravitation, that sort of thing.

All of this has a direct reference, has it not, on our space work? We have got to know how our own world operates here, what operates on this planet, if we are going to apply it and we are going to leave this planet and get back to it, is that correct?

Admiral BURKE. That is correct.

Secretary FRANKE. That is correct.

Mr. MILLER. And this has all been done in conjunction, too. Of course, we are all interested in weather. While we talk about sending satellites up to look at the weather, tell us about the weather. The weather, I believe, becomes the transference of heat, basically. There are other fields where you are also trying to solve this problem in a little more mundane way, are you not, fields of oceanography?

Secretary FRANKE. That is correct.

Admiral BURKE. May I explain? Weather is greatly influenced by ocean currents, for example, as one of many things. There are a few things that happen to ocean currents which happen now and then and we don't know why they happen. For example, the current from the Antarctic which flows north in the Pacific, up the west coast of South America, is called the Humboldt Current. About every 10 years it changes its course and its characteristics a little. As you know, the west coast of South America is normally very dry.

But when the Humboldt Current makes minor changes, there are terrific floods, terrific changes in weather, high winds and regular downpours. Nobody knows why. We want to find out. A more beneficial effect, however, results in the Atlantic with the current there, the Gulf Stream which warms the adjacent land area.

If we can find out what causes those changes, perhaps we can do something to control them some day.

Mr. MILLER. Not only control them, but then we can anticipate and project and know very finally about the weather, can't we?

Admiral BURKE. That is correct.

Mr. MILLER. Without even looking into the heavens?

Admiral BURKE. That is correct, sir.

Mr. MILLER. If we can know about the ocean currents and this transference of heat that takes place in this field, we can come to know as much about the weather from this source as any other source that is available to us.

Admiral BURKE. Yes, sir.

Mr. MILLER. And this is important and the Navy has been doing a great deal of work in this field and I want to congratulate them on it. I happen to serve on another committee, the Committee on Oceanography, that works very closely with the Navy, and I know of these things, know of the great work that you are doing, and Mr. Secretary, I think you have got a great staff, and you are to be congratulated.

I particularly want to pay my compliments to Admiral Hayward, because I won't be here tomorrow when he formally comes on.

The CHAIRMAN. Mr. Chenoweth?

Mr. CHENOWETH. I also want to welcome you to the committee and congratulate you and commend you on the very splendid statements of you and your staff.

Secretary FRANKE. Thank you.

Mr. CHENOWETH. We in Colorado are very proud over the fact that Admiral Burke heads up the Navy operations. I think I speak not only for the people of Colorado, but I think for the people of every State in the Union, when I tell you, Mr. Secretary, we have complete and full confidence in what Admiral Burke is doing and he is to return to Colorado next month to receive a very important award for his outstanding services. I thought you would be interested in that.

Secretary FRANKE. Thank you, I am interested.

Mr. CHENOWETH. I would like to ask you, Admiral Burke, about the top question which is raging in Washington these days and that is about our defense program and just where the Navy stands and whether we are ready to meet any contingency, whether we will be able to deliver the striking load when it is necessary.

I would like to have you give us just your observations, Admiral, on the "posture"—is that the word that they are using today—of the

Navy today as compared to what requirements will be for the Navy to perform in the near future.

Admiral BURKE. Yes, sir. Of course, this is one of the most difficult problems because we are dealing primarily with futures. What is going to happen in the future? What is Russia going to do? What are our allies going to do? What are we going to do? We are trying to balance the possible enemy strength against our possible strength under any contingency which various people can envisage and opinions are always just a little bit different.

Each man envisages a slightly different situation. It is a most difficult problem. Of course, this is a problem in which the Joint Chiefs of Staff, the Department of Defense, all military establishments spend most of their time on.

Right now, I think that the United States is the most powerful country on earth. I think that there is nothing whatever that Russia can do or anybody else can do which can prevent her destruction, if she wants to start a war. There is nothing whatever that she can do to prevent her own destruction if she wants to start a war.

Now, something new has been added. Russia can, if not now, sometime in the future, wreak heavy destruction on this country and there is nothing we can do to prevent it.

Now, when that time comes, is dependent upon a great many things happening, mostly in Russia. We will reach a stage sometime when Russia can inflict severe damage upon this country. But, by doing so, she cannot by any means prevent retaliation and her own destruction.

Now, this is true now. I believe it will be true in the future.

We have many ways, many methods, many systems to deliver that destruction. For example, it is not just by ICBM's, although those are very important. It is not just by IRBM's, those are important, too. We have a few, a few will be in Europe and other places. We have our carriers at sea in the Sixth and Seventh Fleets. These are heavy striking forces that can do a significant amount of harm. The Tactical Air Forces which are deployed all over the world, the Army missiles which are short range, but still can do a great deal of damage, and then, of course, there is SAC, which I think is a powerful force.

Now what is causing concern is the time when Russia gets an ICBM, gets many ICBM's in operation.

ICBM accuracies increase, just due to normal advances in science. Some day this will mean that we can destroy any target on the face of the earth whose location we know and which is fixed with ballistic missiles.

Similarly, Russia will be able to do the same thing to us. There will be other people, other nations that will also have that capability against fixed targets, in known locations. Any fixed target in a known location can be destroyed.

But that means what is needed now is invulnerability, the possession of a force which cannot be destroyed because it is not in a known location. That is, of course, exactly the reason why we stress carriers so much, they are not capable of destruction by ballistic missiles because their address is not known. There is no way that the Russians or anybody else can fire a ballistic missile from the Continent or from anyplace and destroy a carrier because they don't know exactly

where it is. Of course, that is also the reason why we developed the Polaris submarine. When the Polaris submarines come along, as they will—we have the utmost confidence now; the tests have all been successful—it will be impossible to destroy them. There is nothing that Russia can do to destroy that striking power and thereby prevent her own destruction.

If she starts a war, she will be destroyed.

Mr. CHENOWETH. Your statement is most reassuring, Admiral, and I am sure that it reassures the American people as to what our military strength is. One last question:

You mentioned that the Navy is using all of these new techniques in space in the missile program in its preparedness?

Admiral BURKE. Yes, sir.

Mr. CHENOWETH. You feel now that the Navy is making good progress in the use of these new modern techniques and scientific knowledge which we are developing?

Admiral BURKE. Yes, sir. We have, of course, very close cooperation with all the services and all civilian agencies in our research and development programs.

Mr. CHENOWETH. Do you know of anything that is being overlooked in this situation today?

Admiral BURKE. No, sir. We surveyed the question of gaps in our research very carefully to make sure that we aren't overlooking something. Of course, we might be overlooking something, but I don't think so.

Mr. CHENOWETH. Isn't there a tendency to magnify the gaps and really degrade what we are doing ourselves here, isn't that the tendency in this country today? We are reading so much about it every day.

Admiral BURKE. It seems so to me, sir. We have a lot of wonderful engineers in this country, a lot of wonderful scientists, both in and out of the services, both working for the services and for the civilians, sir. We get a lot of advice on what needs to be done and some of it is very good advice indeed.

So if anybody thinks that we are overlooking something, we usually hear about it, sir.

Mr. CHENOWETH. I appreciate that very fine statement, Admiral, and commend you for the admirable job that you are doing. Thank you very much.

Admiral BURKE. Thank you.

The CHAIRMAN. Mr. Sisk?

Mr. SISK. Mr. Secretary, I am interested in people because I think probably people are the most important part of this whole job and I would like to have your comment as to the problems, if such problems exist, in the Navy, with reference to the securing and the keeping of adequate people, adequately trained to do the job for you in research and development in the space field or in the overall field of research and development. What is your basic problem, if the problem exists in this field?

Secretary FRANKE. Well, our principal problem in this very important area is that we compete with industry. Therefore, it becomes difficult to keep people when industry can pay them more. Now, this is not as bad as it sounds, because we have many dedicated people in

the Navy, not only in the research and development effort, but in uniform doing other jobs who are not basically interested in the money.

But we also have others who naturally are. So I think that in brief, the answer to your question is we have problems in keeping people, certainly engineers and scientists.

Mr. SISK. Actually, some of these questions on programs I am sure I will probably direct to Admiral Hayward tomorrow because of his particular responsibility in this field. I was curious to know to how great an extent—we will keep the question general, rather than getting into specific numbers—but to what extent are you dependent in your program of research on civilian and to what extent if you want to use just percentages, on people actually in uniform?

In other words, are the majority of your people actually doing the research, the basic research, and so on? Are they civilian, are they military, or what is the percentage of breakdown?

Secretary FRANKE. It is predominantly civilian, probably 90 percent civilian and 10 percent military.

Mr. SISK. Ninety percent civilian.

Now, what is your situation with reference to paying those people? I appreciate the fact that we do have many dedicated people and we have on this committee from time to time in all branches of the service, seen this dedication at work, yet I wonder sometimes just how much we should depend—and I appreciate the fact that we have these people—but how fair are we being sometimes to expect as much dedication as we have on the part of some people who are working for the Government for 17, 18, 19 thousand a year when they could command 40, 45, or 50 thousand in industry?

Secretary FRANKE. Well, you can answer this question. I don't mean to be facetious about it, but you could ask this question about anyone in this room.

Mr. SISK. I appreciate that, and I know that covers a broad field, separate and apart. But there are problems which we are faced with now, for example, in NASA with reference to making possibly more positions available on a so-called super grade level. That is the thing I am concerned with here. To what extent is the Navy's work being retarded or slowed down if such is the case by a lack of your ability to have positions at higher grade levels?

Admiral HAYWARD. Mr. Sisk, maybe I can answer this. Our chief difficulty comes: We can compete up to about the GS-12 and GS-13 level. We get a lot of young graduates that come into our laboratories and who go up quite rapidly. But when they get to that level, there is practically no place for them to go. We don't have enough super grades.

Having run a laboratory, I know this is one of our problems. It is at that level that our good, trained physicists and mechanical engineers, go to industry. They can't afford to stay with Government really. Actually we don't blame them. We attempt to get around this a great deal by continuing the flow of younger college people and engineers and physicists into the Government again, but it is a problem with the Government, and in all three services, as far as in-house work is concerned.

It is a tremendous problem with NASA as we know. Now, contrary to this approach, the Atomic Energy Commission took the con-

tract approach and have been able to keep top people in Los Alamos and Livermore because with the contract approach, there was no limitation on the actual pay or the number of grades.

When we brought industry in, Western Electric into Sandia, the University of California had to re-do its wage scale and up the price to compete with industry, Western Electric. This is a problem, there is no question about it.

Mr. SISK. I am sure the Department of the Navy is concerned, as I think all branches of the service are concerned with having people in service or in uniform, who have the knowledge and the background to evaluate and to some extent manage these programs and not be completely dependent upon contract and private industry, because we have had this problem expressed many times. It's important to you to know exactly what is going on and whether or not they are producing.

Now, let me ask you this question: To what extent are these new fields of research being stressed in Annapolis today or is primarily the Navy still just training officers——

Admiral BURKE. Just training sailors, sir.

Mr. SISK. Well, Admiral Burke, I think you get the point I am making. In other words, to what extent are the Academies being used to stress these new fields of scientific need?

Admiral BURKE. Not to the extent that I would like to see, sir. We changed the curriculum last year to increase the scientific education of the Naval Academy, but there is a limit on the amount of time which these young men have to learn. They have to know about 10 times more now than they did when I went through there.

In other words, we push them just as hard as we can. We have dropped a lot of the things that they can learn about the Navy after they are commissioned.

So it is not so much at the Naval Academy that advanced education has to be done, because they are undergraduates and they can only come up to the B.S. level. Our educational program now provides for preparing them to absorb more later on.

Now, one of the most difficult problems we have right now is to get enough well-trained officers with the technical background so that they can know what the scientists are talking about and know how to make an evaluation of their work. To overcome that, we are stressing increased numbers of people in advanced education, technical education, but that takes 3 years. This requires an increase in the number of officers. We are short, we have a smaller percentage of officers than any other service except the Marines.

So that is one of the things we are trying to do, get a larger number of officers so that we can give more of them better education.

For example, one thing we are trying to do is take 10 very young officers a year, 5 from the Naval Academy and 5 from the NROTC, who are properly motivated, have the basic background to advance fast, send them to sea for a year for intensive Navy training and then send them to civilian universities for their doctorates. That is 20 to 30 years in the future this is going to pay off. We have increased the numbers of post-graduate students among the older officers, that is men around 25 and 30. These officers are sent to universities after they have been out to sea for a while, to get them well educated.

We will get many more masters degrees that way. But what we need is more scientifically trained officers for the future.

Mr. Sisk. I am glad to hear that you actually have a program of taking these officers and then permitting them to move on to doctorates and so on, because I think this is certainly one program that needs expansion. I want to pay tribute to Admiral Hayward and I think I am giving credit to the proper person.

A couple of years ago, Admiral Hayward made the statement, and I have always remembered it, that regardless of how expert men have become in developing machines and computing equipment, the human brain is still the greatest computer on earth. I believe, Admiral Hayward, you were at least the first person I heard make the statement. I thought many times about it.

Certainly, to me, it seems essential that in your service, as, of course, in all other services, that there should be more emphasis, if possible, Admiral Burke, on doing the things you have described with these young officers, as they come out of the Academy, and giving them the opportunity for those who have the capacity to absorb it, to get this higher education and additional training in order to be able to evaluate what your contracting groups are doing, because without it, I just don't see how you could know whether they are delivering the proper amount of bang for a buck or not.

Admiral Burke. That is correct, also. That is also the reason why Admiral Hayward has the job he has.

Mr. Fulton. Will you just yield for a question, Mr. Riehlman?

Mr. Riehlman. Yes, sir.

Mr. Fulton. I will be interested to hear through Mr. Sisk tomorrow when he questions Admiral Hayward how Seaman Second Class J. T. Hayward got ahead so far, so fast, and has done so well without all this training capacity and facility.

Mr. Riehlman. Admiral, I was delighted to hear your statement in respect to what is being done, and the Navy, particularly, to advance these young people or the officers in the Navy who have an aptitude toward engineering and science.

But isn't there another link in this chain that destroys the usefulness of these boys after assigned to this job, that they have to be moved on into another phase of activity to get their promotion?

Admiral Burke. No, sir. What we need——

Mr. Riehlman. Hasn't that been true in the past, that they have been rotated in the service?

Admiral Burke. Everybody at this table is a technical graduate student.

Mr. Riehlman. Aren't you losing the usefulness of a man who has the qualifications in research and development by rotating him just so that he can be promoted in the Navy?

Admiral Burke. No, sir; that is not the reason they are rotated. What we have to have is the scientist who knows what the Navy requirements are.

And you can't tell him that, he has got to have that experience. He has got to know what nobody can ever explain to another man, what happens at sea—what happens to a ship in a heavy sea and what things have to be done. He has got to have the experience. Just telling him is not enough. What we are trying to do is to bridge the gap between

the people who are the straight scientists, who work in a particular narrow field, and the broad field of Navy requirements.

So we have to have sailors who know their sailoring business, but also who know the scientific business. That is the reason why we have always rotated our trained people.

Admiral Hayward is a third-class physicist. I, myself, am probably a fourth-class explosive expert of many years ago. We have both had that training—many of the senior officers in the Navy have. That doesn't affect their promotion.

As a matter of fact, the people who have technical educations on a percentage basis actually have a better chance for promotion than the people who have not.

Mr. RIEHLMAN. Well, you take a young officer in the Navy who has his background in engineering and some field of science, is he rotated into a field of activity where that is going to be useful to him?

Admiral BURKE. Yes, sir.

Mr. RIEHLMAN. And be exposed?

Admiral BURKE. Yes, sir. It is always useful. As I say——

Mr. RIEHLMAN. And is it going to be in a productive way?

Admiral BURKE. Yes, sir, but not in a narrow field. We aren't training mathematicians, for example, who deal solely with computing mechanisms, and that alone.

What we want are mathematicians who understand computing mechanisms. There will be other scientists who know more than they know, but these officers know how to apply computing mechanisms to the problems of the Navy. To do that they must know the problems of the Navy they must know both.

Mr. RIEHLMAN. I think you said that about 90 percent of the scientists and engineers in the Navy were civilians?

Admiral BURKE. That is about right.

Mr. RIEHLMAN. And 10 percent were officers?

Admiral BURKE. That is about right.

Mr. RIEHLMAN. Do you feel that the 10 percent of naval officers are sufficient to carry on this program?

Admiral BURKE. No, sir; I do not. That is the reason why we are trying to get more and more technically trained officers.

We must have highly educated officers in the future, not only for the things in space, but also for normal shipboard things, a missile, for example, missiles and nuclear power. All of these things demand very highly educated officers.

Mr. RIEHLMAN. Mr. Chairman, I would hate to pass this opportunity when we have been passing out compliments here this morning, to fail to recognize that the Secretary of the Navy comes from the great State of New York and we in New York are delighted to have him as our Secretary.

Now, I want to ask the Admiral one other question.

The CHAIRMAN. The record will show that, Mr. Secretary. He has also been in the Government service for quite a length of time.

Mr. RIEHLMAN. I am sure of that.

The CHAIRMAN. Everybody knows his ability.

Mr. RIEHLMAN. Yes, sir.

The CHAIRMAN. And his devotion to duty.

Mr. RIEHLMAN. Admiral Burke, I know, in response to Mr. Fulton's questioning, the interest the Navy has in the Transit program.

And you were saying that the interests of the other services were recognized, and in this program they were furnishing instrumentation that would be helpful to their field of activity, the Air Force and the Army; am I correct in that?

Admiral BURKE. Not quite, sir. Sometimes they furnish the instrumentation, other times we develop the instrumentation to fit their needs. It is coordinated.

Mr. RIEHLMAN. It is developed to fit their needs?

Admiral BURKE. That is correct.

Mr. RIEHLMAN. Do I understand that that same cooperation, that same program is being carried on in respect to the Air Force in its program of the Midas and Samos?

Admiral BURKE. As a matter of fact, sir, the details of the Midas program are being developed in the Navy laboratories for the Air Force.

Mr. RIEHLMAN. Fine. And the same cooperation and work between the Air Force and the Navy will be true with the Samos in its development?

Admiral BURKE. Yes, sir.

Mr. RIEHLMAN. For the three services, the benefit of the three services.

Admiral BURKE. Yes, sir.

Mr. RIEHLMAN. So that there is a free interchange of knowledge and information and cooperation with respect to the development of these programs?

Admiral BURKE. Yes, sir.

Mr. RIEHLMAN. That is all, Mr. Chairman.

The CHAIRMAN. Mr. Karth.

Mr. KARTH. Mr. Secretary, several areas have already been explored today and I should like to explore still another one if I may. It has been testified to on several occasions before this committee and other committees of Congress and pretty much agreed to by Admiral Burke today that the deterrent powers of the Soviet Union and the United States are so awesome that it is highly improbable that we will have an allout nuclear war because whoever the aggressor may be, they would, in turn, be destroyed. So emphasis is being placed on an overall military posture to fight these brush fire type wars if I may use that expression.

So that leads me to this question, sir: Insofar as fighting a limited war is concerned, as far as the Navy is concerned, are World War II Navy vehicles obsolete at this time?

Secretary FRANKE. Well, it depends on what you mean by vehicles?

Mr. KARTH. Well, your ships and your other Navy vehicle posture that makes up your naval strength.

Secretary FRANKE. Let me put it this way: Carriers are not obsolete. That is, a particular carrier, itself, can be old and worn out, this is true, but the necessity for carriers, for the type of war you are talking about, is still a very definite requirement.

Now, it is true that as we proceed and we get more technical knowledge, that some types of weapons systems will be superseded by others in whole or in part like missiles on board a ship, for example, as compared with guns. This is a transition, of course, that has gone on for many years and I suppose will always go on as we get new ideas and new weapons systems.

But our great problem really is that we have a lot of ships that are old and they are wearing out. They are still usable and we try to extend the life of these ships by better modernization program, but we will meet the day in which they will no longer serve the purpose.

Mr. KARTH. If you could, what percentage of that fleet today is obsolete in the sense of the word that is not capable of shooting missiles, but rather still adheres to the old gun type defense?

Secretary FRANKE. Well, it isn't so much that. You can convert a ship to the use of modern weapons, most ships, but you reach the point after a while when the age of the hull doesn't justify the cost of conversion.

This becomes a very difficult problem. We have done this with a number of ships.

Mr. KARTH. What percentage of our fleet is in this position, would you say?

Secretary FRANKE. We have got about—oh, a very high percentage of our ships are old and are World War II ships.

Mr. MILLER. Would the gentleman yield for a question?

Mr. KARTH. Yes, sir.

Mr. MILLER. Isn't it true we can give you the most modern carrier, but if they don't have ancillary ships such as oil tankers, that are modern and up to date, you can't keep her at sea very long and isn't this one place where the Navy is particularly weak right now that we haven't given you any new tankers and you are patching them to keep them together in some parts of the world?

Secretary FRANKE. No, I don't think so. Of course, for a carrier, a modern carrier, it depends on whether it is nuclear or conventional. But a modern nuclear carrier can stay at sea for an unlimited length of time. It is a question of the crews, really, replacement of crews.

Mr. MILLER. But you do have some trouble with your ancillary ships, you had it last year?

Secretary FRANKE. Yes, and we always need more.

Mr. MILLER. Thank you.

Mr. KARTH. Mr. Secretary, I am attempting to find out what part of the Navy's fleet is of such obsolescent nature that it really doesn't justify converting it to other means of warfare and, in effect, therefore, pretty much mandates new vehicles? What part of the Navy's fleet is in that position?

Secretary FRANKE. You mean new ships, particularly?

Mr. KARTH. Yes, sir.

Secretary FRANKE. Admiral Burke, why don't you take that over. It is a difficult question.

Mr. KARTH. Surely.

Admiral BURKE. Seventy-eight percent of the ships in our present fleet are World War II ships.

Those ships are not nearly as capable as modern ships. And they cannot do the jobs that a modern ship can do. But still they are useful.

For example, these old ships have SQS–4 sonars on them, for example. It is not nearly as good equipment as the more recent sonars. But still the old ships so equipped will be useful. They will do some work as long as they can be held together. We are trying to hold them together by modernizing them as much as we can for another 5 to 8 years. The day will come, however, when the hulls, the machinery,

the piping, the wiring—like the one-horse shay, they will just fall apart.

Mr. KARTH. Admiral, we can't wait for that day to come.

Admiral BURKE. No, sir, we can't wait for that day to come.

Mr. KARTH. Are we doing everything now, is the budget permitting everything to be done so that the modernization of the Navy can take place over this 3- to 5-year period?

Admiral BURKE. We now have now about 860 ships in the fleet. Our shipbuilding bills over the last few years have provided an average of 22 new ships per year. The average life of a ship, and it varies among ships, we can say is about 20 years; 20 times 22 is 440 ships. This is considerably less than 860.

Mr. KARTH. So we are moving about half as fast as we should, is that what you are saying?

Admiral BURKE. What I am saying is that with a shipbuilding program of that extent, you cannot keep an 860-ship Navy forever. Sooner or later, the ships are going to wear out.

Mr. KARTH. How much money was originally requested by the Navy for modernization of the Navy in this area and how much money has been allowed in the budget for this purpose?

Admiral BURKE. Our budget was submitted this year on a guideline basis. We were given two guidelines at the beginning, in July. One of them was an NOA guideline which was equal to the budget in 1960 less 10 percent of the procurement, military construction, and research and development appropriations.

The other one was an amount equal to last year's budget plus half a billion dollars.

Those were the two guidelines that we were given. We submitted our budget based upon those guidelines.

Mr. KARTH. And what did you get, sir? What is being requested?

Admiral BURKE. Well, it is in between. All the services are in between the basic budget and the addendum.

Mr. KARTH. And in dollars and cents figure, how much difference does this amount to?

Admiral BURKE. We did not submit our requirements this year. We had a requirements budget, which we developed for ourselves, which amounted to about $19 billion. Then we cut that down, the Commandant of the Marine Corps and myself, to about 15 billion by cutting out the least urgent projects.

The CHAIRMAN. May the Chair interrupt here? We don't want to get too far afield from the purpose of this, which is the development of space. I am trying to give everybody all the time they want this morning. We have 40 minutes to finish with the committee.

Mr. KARTH. If I may, I should like to submit several more questions in writing to the Admiral and ask for his answers to be put in the record.

The CHAIRMAN. All right. Don't get into the question of the operation of the Navy, because that is not our jurisdiction.

Mr. KARTH. I am very interested in it.

STATEMENT IN ANSWER TO CONGRESSMAN KARTH'S QUESTION

(1) How much money was recommended in Navy for "modernization" of the Naval Fleet?

Answer. Modernization is not considered a separate item in Navy budget planning, since all programs are aimed toward future effectiveness of the

fleets. Extraction of the figures for procurement of new missiles, aircraft and other equipment, ship construction, ship and aircraft conversion and overhaul and research and development, all of which may be considered modernization, provides an approximate total figure of $12 billion originally proposed by the program sponsors for fiscal year 1961.

(2) How much money was allowed in the budget for this purpose?

Answer. Approximately $6 billion.

(3) Does the money provided adequately provide for modernization over the "20-year" period?

Answer. The funds provided are not sufficient to modernize a fleet of the present size over the period of 20 years.

(4) How many nuclear subs were requested by Navy? (Assume this to mean "How many SS(N) did the Navy request from the Department of Defense in fiscal year 1961 budget?")

Answer. Four SS(N) were included in the Navy fiscal year 1961 budget request to the Secretary of Defense.

(5) How many nuclear subs are provided for in the budget?

Answer. Three SS(N) are included in the President's fiscal year 1961 budget.

(6) How many submarines do we have with Polaris capability?

Answer. Nine SSB(N) have been authorized plus long leadtime items for three more in fiscal year 1961. The first of these nine SSB(N), the U.S.S. *George Washington*, SSB(N) 598, was commissioned December 30, 1959. The second will be commissioned March 31, 1960.

(7)(*a*) How many (SSB(N)) have been requested?

Answer. Within the framework of the Navy's overall requirements and resources available, four SSB(N) and long leadtime items for four additional SSB(N) to commence in fiscal year 1962 were included in the Navy submission to the Secretary of Defense for inclusion in the fiscal year 1961 budget.

(*b*) How many (SSB(N)) are provided for in the fiscal year 1961 budget?

Answer. Three SSB(N) and long leadtime items for three additional SSB(N) in fiscal year 1962.

(8)(*a*) How many CVA(N) had been requested?

Answer. The Navy submission to OSD requested one CVA(N).

(*b*) How many CVA(N) are provided for in the fiscal year 1961 budget?

Answer. None, however, one CVA is provided for in the fiscal year 1961 budget.

(9) What percent of the Navy fleet is of World War II vintage?

Answer. Of the 864-ship inventory, December 31, 1959, about 78 percent were of World War II or prior construction.

(10) What percentage of this is obsolete or fast becoming obsolete?

Answer. Two factors contribute to the obsolescence of our ships. These are old age and technological deficiencies.

Of the portion of the June 30, 1960, ship inventory that are of World War II or prior construction, the following ships will become overage as shown below:

Fiscal year	Number	Percent of 864 fleet
1961	298	34.5
1962	300	34.7
1963	310	35.9
1964	347	40.2
1965	477	55.2
1966	507	58.6

Technological advances in electronics, weapons systems, and propulsion systems has compounded the obsolescence of our older ships and even rendered many of our underage and some of our post-World War II ships obsolescent to some degree.

The CHAIRMAN. So are we all.

Mr. MCCORMACK. Who gave the guidelines?

Admiral BURKE. Secretary of Defense.

Mr. MCCORMACK. Who gave him the guidelines?

Admiral BURKE. I don't know, sir.

The CHAIRMAN. Mr. Hechler?

Mr. HECHLER. Admiral, in addition to your concern about getting technically trained officers through Annapolis and through the regular officers' system, don't you have a very great stake in the quality of our general education system in this country?

Admiral BURKE. Oh, yes, sir. Both in our educational system and also in the motivation of youngsters.

Mr. HECHLER. Isn't it just as important—even though you are interested in the construction of hardware today—isn't it just as important to make sure that our educational system will provide us the brains to improve our hardware, keep us developing and moving ahead in the future?

Admiral BURKE. Yes, sir; and that is the reason why we are particularly interested in the quality of people. These young men have the capacity to do remarkably good work and then are not motivated to do work up to their capacity.

Mr. HECHLER. I would very quickly now like to turn to a question for the Secretary of the Navy.

Last year when Admiral Hayward testified before our committee, Mr. Secretary, he spoke very cogently of the danger that both our missile and space programs might be choked by bureaucracy. Admiral Hayward said there was some danger that we might lose out to Russia, not so much through a lack of scientific or military talent, but through the choking effect of too many bureaucratic committees and a lack of responsibility and control.

And to me, Admiral Hayward made the most sense of any of the witnesses who commented on the organizational structure of our missile and space effort when he advised that there should be a single space program akin to the Atomic Energy Commission with a military applications division, something that would provide central leadership, responsibility, and control. After he made these comments, I asked a number of the witnesses, both in the Defense Department and other services about this suggestion and they all said things like: Well, competition is good, it is part of the American system; or, don't disturb the organization we have.

The NASA organization disturbs me a great deal because it assumes that the interest in space is exclusively civilian and it worries me very, very much that the military may have insufficient voice, when it wants to carry on operations and research which will directly affect the national security in the future.

You can do this with liaison, with committees, with coordination, with collaboration, but it seems to me that not only from the standpoint of the military interest, but from the standpoint of an understanding of the people in this country, that there needs to be a more clear-cut leadership and direction over this whole effort. I wonder if you care to comment on that?

Secretary FRANKE. Well, I think that—personally, I think that this present division as between NASA and Defense will work and will work well. Everything that you do in any walk of life or in any effort depends upon people, depends upon the coordination of people, their willingness to talk to each other.

I think that there can be a fairly clear-cut division between what NASA is trying to do and what the Defense Department is trying to do.

Now, one of the reasons why I would favor that type of organization rather than one overall agency being responsible for all efforts in space is that if we had the responsibility in Defense, maybe we would give too much emphasis to Defense needs, and by the same token, if NASA had it, maybe they would give too much emphasis to peaceful operations.

Mr. HECHLER. May I interrupt to suggest that I am not saying defense should control this agency or the military should control it, but one single person, perhaps, could provide the oversight and control and put the whole thing in its proper perspective. Let's face it, there is a military interest in space.

Secretary FRANKE. There undoubtedly will be, yes, sir.

Mr. HECHLER. There is.

Secretary FRANKE. There is at the present time, yes.

Mr. HECHLER. One further question, Mr. Secretary: Wouldn't your job be much easier if all of the American people were really alerted to the nature of the threat which confronts us?

Secretary FRANKE. Yes, I suppose that is true. This is very difficult to get across to the American people because they read all sorts of differing views in the newspapers and they are certainly confused, I am sure of this.

Mr. HECHLER. You are saying that the newspapers are not reporting it accurately?

Secretary FRANKE. No, I don't mean that. I think that the newspapers are reporting what different people think and I think it is perfectly normal that—Admiral Hayward, for example, in his area, thinks that he has the most important job in the Navy, I am sure, and he should feel that way.

So that you get dedicated, intelligent, able people who present their views from their own standpoint and I think this is right, but this is what confuses the American people, because somebody else also thinks he has the most important job.

Mr. HECHLER. Mr. Secretary, you have just given the most powerful argument for what I have been trying to advocate. Thank you, sir.

The CHAIRMAN. Mr. Daddario.

Mr. DADDARIO. No questions.

The CHAIRMAN. Mr. Moeller.

Mr. MOELLER. Some of us in this committee are confused, too, we spell confused with "k" now because we are so confused.

Two brief questions. I would like to direct this one to Admiral Burke. It is maybe a little bit irrelevant now. The replacement ships are all American built, are they not?

Admiral BURKE. Yes, sir.

Mr. MOELLER. How about the repairs for these ships, are these also American repair productions?

Admiral BURKE. It depends on where a ship is when she is damaged.

Mr. MOELLER. If it is on our coast lines.

Admiral BURKE. Repairs are made in American yards, yes, sir, that is correct.

Mr. MOELLER. Are we paying a premium sometimes for American made things? Just yesterday I heard a statement of a shipbuilder in Ohio who said that he could get a far better propeller with better

materials, better workmanship for far less money from an oversea supplier. This appears as though we are paying a premium here, maybe, for American-made things.

Now, I am not telling the Navy where to make its purchases, but possibly the better thing would be even cheaper for us if we made a thorough investigation into who is making what for these naval repairs.

Admiral BURKE. You are correct. There is a Buy American Act, of course, which we abide by. You have touched upon, I think, the biggest threat to the United States that we have and that is the ability to compete, the ability to compete in the manufacture of things, the ability to compete in education, the ability to compete in getting our views across to the world, particularly to these nations which are just now being formed.

This competition is very keen and we are going to have to compete and on rules which we sometimes don't make. It is a very important thing. It is bad when the same quality steel can be laid down at the door of one of our steel plants at a lower price than we can make it. I understand that sometimes that can be done and that means we are out of the competition.

Mr. MOELLER. I am glad to hear that statement. Now, my second question is this: We are all very pleased with what you are doing with the Polaris. It occurs to me that we would need far more submarines, knowing what the Soviet Union has, than we have today. Have you been denied requests for more submarines with Polaris installations?

Admiral BURKE. You have got two parts to your question.

First, on the numbers of Polaris submarines. We did request more Polaris submarines, of course, than are in this budget. However, those additional submarines were not granted at that time because the system was not yet fully operational and the reason was given that we should plan to continue a three-a-year rate until the weapon system had been better tested.

We expect that when the system is operational we will have a larger Polaris program. We think that will be very soon indeed, since we have passed all the major milestones which marked the major difficulties that we anticipated with the Polaris. We are sure it will work now.

Second, as the Secretary said, the last five Polaris shots have all been successful, remarkably so. We anticipate that perhaps we will be permitted to submit a supplemental for more Polaris submarines.

Mr. MOELLER. I am glad to hear that. It takes a long time to make a submarine.

Admiral BURKE. It takes a long time to make a submarine, about 32 months.

Mr. McCORMACK. Will the gentleman yield? How many Polaris do we have built or in process of construction?

Admiral BURKE. Nine, sir. There are three more in this budget, of course.

Mr. McCORMACK. That will be 12.

Admiral BURKE. Twelve, yes, sir.

Mr. McCORMACK. Of those 12, I think 5 or 6 or 7 are due to money appropriated by Congress over the budget in past years?

Admiral BURKE. That is correct, sir.

Mr. FULTON. May I ask a question?

Mr. McCORMACK. And on the Polaris it was felt, while it was a calculated risk, that the missile, itself, justified the building of the submarines rather than have that big gap to wait until after complete perfection?

Admiral BURKE. Yes, sir.

Mr. McCORMACK. I think it was a wise calculated risk to take.

The CHAIRMAN. Mr. King?

Mr. KING. Admiral Burke, will the navigational aids provided by your Project Transit be of value to aircraft as well as surface craft?

Admiral BURKE. Yes, sir. Not the original Transit but in the future they will supply this information.

Mr. KING. The Navy, then, will in effect be offering a service that will be of value to——

Admiral BURKE. Well, it will be of value to all ships and aircraft, not only to our armed services, but to anybody else who gets the ephemeris.

Mr. KING. That was going to be my next question. Then you are going to be, in effect, providing a service for the Air Force and for the civilan aspects of this?

Admiral BURKE. That is correct.

Mr. KING. Civilian surface craft, civilian aircraft, and for other nations as well?

Admiral BURKE. That is correct, sir.

Mr. KING. Now, have the details of that been worked out? I can see business implications. Do you sell your services or how does it work out?

Admiral BURKE. No, sir. That will be almost like a star. There will be an ephemeris printed and data will go out every morning, periodically as often as necessary but probably every day, on the orbit of the transit. Any ship or aircraft that has the equipment to read it out can use the satellite. The equipment is not expensive and will be built by commercial concerns.

Mr. KING. Then this is a service provided gratis to anybody who tunes in on it, then?

Admiral BURKE. Yes, sir; in the world.

Admiral HAYWARD. We will give a presentation to the committee on that.

Mr. KING. Yes. Is my time up?

The CHAIRMAN. No.

Mr. KING. I have a couple of other short questions, Mr. Chairman. Doesn't the development of your Polaris program render relatively less necessary the need for your carriers?

Admiral BURKE. No, sir. There are two reasons for that. One is the contribution of carriers to general war, and second, to limited war.

It is very bad to have a single weapons system and be absolutely dependent upon it. If you are dependent absolutely on a single weapons system, then the enemy can concentrate all of his effort on countermeasures to that system.

Another thing is that the carrier can contribute significantly in retaliation. There are 200 attack aircraft on the alert ready to go in

the Sixth and Seventh Fleets. That is a significant number of aircraft, attack aircraft, which can assist a great deal in a nuclear war strike, if that is ever required.

But the big need for a carrier is in limited war, in wars where we will go up against the best aircraft that the enemy can provide. Although a war is limited, the equipment that is used in a war is not necessarily limited.

For example, in the Taiwan Straits affair, the equipment we would have had to go up against, if the Chinese Communists had attacked us, would have been the best equipment in the Communist world. We would have needed the very good equipment we did have.

Mr. KING. What other nations have carriers?

Admiral BURKE. Britain and France.

Mr. KING. And the Soviets have none?

Admiral BURKE. The Soviets have none. There is a very good reason for that. All of the Soviets' allies are adjacent to them. If we want to fight, we must carry the war to the enemy. If we want to support our allies, they must be supported overseas. Our own forces, many of our own forces are overseas. The forces of our allies and our own would be destroyed if we ever lost control of the seas. The battle areas for limited war are away from the United States.

So we have to take our own power with us and we have to be able to exercise that power any place in the world. When trouble is started by somebody else, they choose the time and they choose the place. And they will choose those times and places to be the most inconvenient possible for us. So we have to furnish the military power. Air Power is a great portion of that military power and is essential to protect other nations and to protect our own deployed forces.

Mr. KING. Thank you.

The CHAIRMAN. Mr. Roush?

Mr. ROUSH. Admiral Burke, does the Navy have any present military need for a super booster vehicle such as the Saturn?

Admiral BURKE. No, sir; not that we can foresee.

Mr. ROUSH. I said presently.

Admiral BURKE. No, sir.

Mr. ROUSH. Do you have any in the future that you can foresee for a super booster engine beyond that which we now have?

Admiral BURKE. I can perhaps envisage big satellites which we would like to have, but there is no specific need, sir.

Mr. ROUSH. All right. A couple of questions concerning the Polaris.

When a Polaris is fired, is it controlled and tracked and is everything done that is necessary to be done within that submarine or do we need other vehicles to assist in its operation?

Admiral BURKE. No, sir. All the data that is necessary for the firing of a missile is in the submarine and just before the missile is fired, all the data is put into the mechanism in the missile. Once the missile is fired, there is no control over it. It has gone.

That is not true, of course, on a test range. You can destroy a missile on a test range. It has a lot of equipment in it.

Mr. ROUSH. Yes, I understand.

All right. Now it was announced some time ago that Russia is also developing a submarine similar to the Polaris.

Admiral BURKE. She has developed some missile-firing submarines. They are not exactly similar to Polaris. They have shorter range, but she has missile-firing submarines.

Mr. ROUSH. Are those operational now?

Admiral BURKE. The submarines are, yes, sir. Whether or not they have the missiles in them we don't know.

Mr. ROUSH. Do we know how many she has?

Admiral BURKE. Yes, sir.

Mr. ROUSH. And is this matter of its range common knowledge?

Admiral BURKE. Yes, sir; it is common knowledge, it is short range.

Mr. ROUSH. What is the range?

Admiral BURKE. 350 miles or less at the moment. That is what we estimate.

Mr. MCCORMACK. Will the gentleman yield right there?

Mr. ROUSH. Yes.

Mr. MCCORMACK. Have you any information about an unmanned submarine that the potential enemy might have?

Admiral BURKE. No, sir. That is some sort of torpedo mechanism. No, sir, we have no information.

Mr. ROUSH. I have no further questions.

The CHAIRMAN. I would like to ask a question now, if I may.

Mr. Secretary, perhaps I ought to ask you this question. It is controversial, but what effect is the development of the Polaris submarine and the Polaris missile going to have on the use of carriers by the Navy?

Secretary FRANKE. It won't have any effect. They are really two different things. The Polaris submarine has, of course, a great capability for all-out nuclear war. A carrier also has a capability in this respect, but it has a tremendous capability for limited wars. This is the ability to be on the spot at the right time. I don't think there is any—I don't think Polaris, for example, in any way eliminates the use of carriers.

The CHAIRMAN. Then leading up to the next question, this inflatable airplane, regarding which we have said a good deal, if that develops as some hope it will, what effect will that have on the use of carriers? I have heard that discussed.

Secretary FRANKE. None that I know of. Admiral Hayward is better able to answer that question than I am.

Admiral HAYWARD. Assuming that it worked, it would permit you to carry a lot more aircraft aboard a carrier.

The CHAIRMAN. It would permit the aircraft to be carried aboard almost any type of Navy vessel, wouldn't it?

Admiral HAYWARD. Well, as I say, that is assuming that it works.

The CHAIRMAN. We are assuming it would work, if you are going to put it on carriers.

Admiral HAYWARD. It would not necessarily be carried aboard all other types of Navy vessels, because you have to get it back again. Actually what would change the carrier more than anything else would be our real vertical take-off type of machine rather than the Wagmight proposal.

The CHAIRMAN. Now, as for the Wagmight, suppose it does work out, just as you would hope that it might, what effect will it have, then, on the use of carriers?

Admiral HAYWARD. Well, it will permit you to store an awful lot more airplanes than you can now.

The CHAIRMAN. On carriers?

Admiral HAYWARD. Yes, sir.

The CHAIRMAN. And permit storage on other vessels?

Admiral HAYWARD. On other vessels.

The CHAIRMAN. Now, what about the other development, the vertical take-off, what effect would that have on carriers?

Admiral HAYWARD. This would probably change configuration somewhat. Once again like all of these developments, it has to be competitive. You either have to get a new capability from it or to do the same job you are doing today better. It would help the Marines, the Army and the Air Force.

The VTOL would probably change the carrier configuration and it would probably have a tremendous impact on the way we actually did our operations.

The CHAIRMAN. It would have an impact on the future designing of your ships, wouldn't it?

Admiral HAYWARD. Yes, sir, it would. The probability of VTOL depends on solving the technical problem of getting an engine with a thrust to weight ratio much greater than we now have. You have to have at least 15 to 1. Our normal engines now run around 6 to 1. The reason for this high thrust to weight ratio is that you do have to hover and this takes lots of power and lots of fuel. This is a component research program that the Army, the Navy, and the Air Force are working on now in the engine field.

The CHAIRMAN. It is just a little speculative at this point, but nonetheless, it is something to think about.

Admiral HAYWARD. We certainly are thinking about it, Mr. Chairman.

The CHAIRMAN. I want to ask another question. We had several years ago an atomic breakthrough so that we could develop smaller atomic warheads and that permits now the development of missiles as we are using in the Polaris.

What about Russia? Has Russia ever developed that breakthrough on the atomic warhead?

Admiral HAYWARD. Do you want to answer it, Admiral?

Admiral BURKE. She probably has, sir.

The CHAIRMAN. She probably has ability to make a smaller atomic payload?

Admiral HAYWARD. Yes, sir.

The CHAIRMAN. Just as we have?

Admiral HAYWARD. Yes, sir, she would.

The CHAIRMAN. I want to ask you this. I think you testified the Navy was satisfied as to current level of funding for its various missile programs. I think Admiral Burke testified to that.

Admiral BURKE. No, sir, if I——

The CHAIRMAN. Well, all right, if you didn't. I got that impression.

Admiral BURKE. There are several things that no man is ever satisfied with. No man is ever quite satisfied with the salary that he gets nor is any military man quite satisfied with the money that is given to his programs, sir.

But we accept this program. Somebody must make the decision, sir. So we support the President's budget.

The CHAIRMAN. Well, wherein are we short, according to the views of a great Navy man, which is yourself?

Admiral BURKE. Our greatest shortage, sir, is new procurement. We need ships, we need——

The CHAIRMAN. No, I am referring now purely to the missile program.

Admiral BURKE. To the missiles?

The CHAIRMAN. Yes.

Admiral BURKE. Polaris submarines and more surface-to-air and air-to-air missiles, sir.

The CHAIRMAN. How many more Polaris could you use at this time?

Admiral BURKE. We anticipate that a total of about 45 Polaris submarines will be all that we will require.

The CHAIRMAN. And you have?

Admiral BURKE. We have nine. We can build submarines at the rate of about one a month after we have a year's buildup. It takes about a year to build up to that rate.

The CHAIRMAN. So it would take you 15 months to start turning the Polaris out when you are ready to go?

Admiral BURKE. No, sir, we can turn them——

The CHAIRMAN. I mean at the rate of one a month?

Admiral BURKE. Yes, sir, that is correct.

The CHAIRMAN. And you need 45, whereas you have now in the mill only 15?

Admiral BURKE. Twelve, sir.

The CHAIRMAN. Twelve. Only 12. We are short, then, a considerable number of Polaris submarines.

Admiral BURKE. Yes, sir.

The CHAIRMAN. Is there anything else we are short, in respect to the space program?

Admiral BURKE. Do you want to answer that?

Admiral HAYWARD. We could use more money in research and development.

The CHAIRMAN. How much could you use?

Admiral HAYWARD. Well, in the missile area, exclusive of Polaris, there is about $80 million that we could use. But I accept my boss' decision on this. If I ever was satisfied with the amount of money I had, he probably would fire me, too.

The CHAIRMAN. Admiral, that is true. You may accept his decision, but I don't know whether the members of the committee would accept it. If you will tell us what you really have in mind.

Admiral HAYWARD. Well, in the missile field primarily we could spend more money in what is known as the advanced weapons system. This is the surface-to-air missile system, which has the primary requirement of defending our ships at sea against air-to-surface missiles. We have less money than we need in the missile systems which we are going ahead with to replace the gun in the 1965 to 1970 era. We are going to have to replace the gun with the missile.

In these areas there is a considerable sum of money involved. I can furnish the committee a detailed list of what is involved.

The CHAIRMAN. I wish you would, Admiral, yes.

Admiral HAYWARD. All right, sir.

The CHAIRMAN. We would be interested.

Additional requirements for guided missiles (exclusive of Polaris)

Missile systems:	*Additional requirements*
Typhoon:	
Long Range	$11,800
Medium Range	14,400
Eagle	4,067
Tartar/Talos	1,050
Sidewinder 1C	2,000
Corvus	2,013
Bullpup	2,000
Total, missile systems	37,330
Guided missile exploratory devices and supporting research (guidance, fire control, propulsion, propellants, etc.)	20,625
Pacific Missile Range support	19,216
Total	77,171

The CHAIRMAN. Does the Navy have a requirement for the man in space program?

Admiral HAYWARD. We don't have a requirement as such. We certainly support Project Mercury. Four out of the seven people are naval aviators. We have a pretty good chance of placing a Navy man in space. The odds are 4 to 3, of course.

The CHAIRMAN. You have to support them, then?

Admiral HAYWARD. Oh, yes, sir. As a matter of fact, some people feel that the Navy man will go because then the Navy will be sure to recover him.

One is actually a marine, Mr. Chairman.

The CHAIRMAN. You think the Marines will make the recovery?

Admiral HAYWARD. Maybe the Marines will make it.

The CHAIRMAN. What about the weather satellite, do you have a requirement for this?

Admiral HAYWARD. Yes, sir, we do have a requirement and we are working quite actively with NASA on this. There was a decision made a year and a half ago to give the weather satellite to the space agency.

We are working for the Department of Defense with the Army and the Air Force, of course. We will present in detail to the committee just what is going on in this field on the weather satellite.

The CHAIRMAN. Fine. We look forward to your testimony tomorrow.

Mr. Fulton?

Mr. FULTON. The question comes up, the Polaris has been working so well, and when big boosters and big thrusts are now so popular. Could you possibly cluster the Polaris?

Admiral HAYWARD. It is a possibility, Mr. Fulton. Any time you put large solid rockets together of that type you always have difficulties with what we call resonant burning.

We haven't considered putting Polaris as a cluster. We certainly would look at Polaris for any seaborne launchings that we want for

satellites, however, because it would give you the opportunity to put about 180 pounds into orbit very easily.

Mr. FULTON. Then on your communications work on the research on using the moon as an earth satellite, actually it is the Navy that has first put the Moon to any practical use, is it not?

Admiral HAYWARD. That is right.

Mr. FULTON. On that reflecting relay program of signaling.

Admiral HAYWARD. Yes, sir.

Mr. FULTON. The Russians are always claiming firsts with the Moon. I think we ought to get some publicity out to the fact that we first put it to any practical use.

Admiral HAYWARD. That is true.

Mr. FULTON. Are you free to comment on what there might be the status on using the Moon for surveillance purposes?

Admiral HAYWARD. No, sir.

Mr. FULTON. Are you free to comment on ion emission programs?

Admiral HAYWARD. No, sir.

Mr. FULTON. Do you have any programs in prospect on the use of energy for reducing or deflecting or upsetting the target range of enemy missiles? Have you done any work on that?

Admiral HAYWARD. No, sir. We have looked at the problem because as you know, with the Russian submarine we have to be prepared to fight the Polaris-type system as well as to have it.

As Polaris succeeds we look very hard at this problem. It is quite apparent, technically, that the place to work on the ballistic missile is the first part of the trajectory instead of when it is coming down at you. We are looking at it, but we have no solution, I must say.

Mr. FULTON. Do you need any more money for detection on enemy craft such as submarines?

Admiral HAYWARD. Yes, sir. In our submarine warfare we do have requirements for more money. I can also furnish that list.

Mr. FULTON. Put that in the record if you will.

Admiral HAYWARD. Yes, sir.

Fiscal year 1961 summary of additional antisubmarine warfare research development, test and evaluation needs

Category research development, test and evaluation:	*Cost in millions*
Classification and detection	$89, 296
Weapons and ordnance	18. 684
Vehicles and propulsion	15. 771
Collateral support	9. 885
Total	133. 638

Mr. FULTON. One last question if I may, that is on your OP. 54 program, on a possible maneuverable manned space vehicle. Is that in prospect and is it in competition possibly with the manned Mercury space project?

Admiral HAYWARD. We are looking at that from a study point of view primarily, Mr. Fulton. Frankly, if you can maneuver something in space, it is important.

Whether it has a man in it or not is immaterial really to that part of it. You have to be able to maneuver it accurately. This is the important problem.

Mr. FULTON. So your study is more along the maneuverability in space?

Admiral HAYWARD. Yes, sir; more than the man in it.

Mr. FULTON. Would you say that was the purpose of the Connally report?

Admiral HAYWARD. Yes, sir; I believe so.

Mr. FULTON. That is all.

The CHAIRMAN. Admiral, would you say you are participating in the simplification program? I am very much interested in that. I think it has possibilities. The program to simplify the complexity of these large missiles, these systems.

Admiral HAYWARD. Yes, sir, Mr. Chairman. This is one of my very strong "hobbyhorses." I think only by simplifying some of these are you really going to make them operational and reliably operational. We have to simplify the electronics. We are doing a lot of work in molecular electronics which we hope will enable us to do away with some of the things which we believe now are simple. This is a large effort. It is an effort in Admiral Bennett's shop, Office of Naval Research, and we are striving all the time to simplify the things.

The ballistic missile is an excellent "beast" now and with the inertial system, I suppose it is no surprise to you that those floated gyros in there cost about $15,000 to $18,000 apiece. If we could make them for $3,000 apiece, we would be a lot better off.

But in order to get a system like that, you go through this stage of complexity. We are very vitally interested in any way we can to simplify our systems. That is across the board. Not just missiles.

The CHAIRMAN. Thank you very much. Mr. Daddario has one question and then I want to say to the committee I have a note here from Mr. McCormack. He says our bill will come up right after the three district bills which shouldn't take any length of time, that we all ought to be on the floor promptly at 12 o'clock.

Mr. DADDARIO. Admiral, last year you testified that we needed 45 Polaris submarines to do the job and testified to that today. Taking the present rate into consideration, when will we get these 45?

Admiral BURKE. Well, if we build three per year, it will take, of course, 15 years. Subtracting the nine we have built or building, it will be about 12 years from now.

Mr. DADDARIO. When, in your consideration, taking the country's security as one of the necessary items, should we have those 45?

Admiral BURKE. Well, we feel that the Polaris submarine, because of its invulnerability and accuracy, and because it can be used under such a variety of general war situations, will be a very important segment of our total retaliatory power.

And, of course, we feel that a high rate of production would be profitable.

The CHAIRMAN. Thank you very much, Mr. Secretary.

Mr. RIEHLMAN. Mr. Chairman, I have just one quick question.

The CHAIRMAN. We are going on the floor.

Mr. RIEHLMAN. Just one question.

The CHAIRMAN. Mr. Riehlman, just one question.

Mr. RIEHLMAN. In your program of research and development, Mr. Secretary, is there any possibility of converting the Naval Gun Factory here into one of your research programs?

Secretary FRANKE. Not that we can now foresee. The building and equipment doesn't lend itself at the minute. This is under investigation.

Mr. RIEHLMAN. You don't have any definite plans?

Secretary FRANKE. We don't have.

The CHAIRMAN. The committee will adjourn until tomorrow morning.

(Whereupon, at 11:57 a.m., the committee adjourned to reconvene at 10 a.m., Tuesday, February 9, 1960.)

REVIEW OF THE SPACE PROGRAM

TUESDAY, FEBRUARY 9, 1960

HOUSE OF REPRESENTATIVES,
COMMITTEE ON SCIENCE AND ASTRONAUTICS,
Washington, D.C.

The committee met at 10 a.m., Hon. Overton Brooks (chairman) presiding.

The CHAIRMAN. The committee will come to order. I think yesterday when we adjourned everybody had been sworn in except Admiral Pirie, who was not here. May I, Admiral?

Do you solemnly swear that the testimony you will give before this committee in matters now under consideration will be the truth, the whole truth, and nothing but the truth, so help you, God?

Admiral PIRIE. I do.

The CHAIRMAN. Have a seat, Admiral.

Now, before we get into the statements, I want to say that some time ago, while I was at home, Mr. Lankford, of Maryland, one of our colleagues, wrote us about a naval station here in Washington being used for missile purposes and I asked the staff to look into the matter and give Mr. Lankford, on behalf of the people of this area, a report.

Now, we have called Mr. Lankford and, if he is available and wishes to come here, I had proposed to the admiral if he has any report to make on that particular project, and if so, to give us the report this morning. But we won't bring it up until he is here, out of courtesy to him.

Now, Admiral Pirie, you have a statement, and Admiral Hayward has a statement. Admiral Hayward, shall we proceed with your statement?

Admiral HAYWARD. Mr. Chairman, if it is all right with you, I would have Admiral Pirie begin. His statement is relatively short on the operational side and my statement is pretty long and detailed.

The CHAIRMAN. Fine. Admiral Pirie, we are very happy to have you. I think this is the first time we have had you before our committee. We welcome you here.

Admiral PIRIE. Thank you, Mr. Chairman.

STATEMENT OF VICE ADM. ROBERT B. PIRIE, USN, DEPUTY CHIEF OF NAVAL OPERATIONS FOR AIR

Admiral PIRIE. I am Vice Adm. Robert B. Pirie, USN, Deputy Chief of Naval Operations for Air. As Admiral Burke's deputy for air, I have been given, in addition to my responsibilities in the aeronautical field, the responsibility for astronautics and space plans, programs and requirements—operational plans, programs and requirements as distinct from those in research and development.

While naval space activities in the field of research and development have been going on for a number of years, it became quite evident during this past year that there were aspects of the national and Defense Department space programs that would require considerable staff effort outside of the research and development field. These fell principally into two categories: First, the formulation of those requirements which the Navy might have for space vehicles or satellites which would enable us to better perform our missions and, second, the support of space operations, both national and Department of Defense, with resources, facilities, and forces of the Navy. These operational needs clearly pointed to a requirement for operational staff direction as distinct from those of research and development.

With attention focused on operations, I should like to present to you today some views on the naval uses of space which the Navy believes are pertinent to your consideration of the overall national space effort.

As previously stated by Secretary Gates, it is approved policy that the Navy will use space to accomplish naval objectives and prevent space from being used to the detriment of those objectives. Specifically, the Navy will pursue the necessary research and technological developments which will enhance its ability to conduct operations in space which are in support of the roles and missions presently assigned to the Navy. At the present time there are considered to be 10 areas wherein the Navy believes that its objectives may be accomplished more effectively by space systems. Ten operational requirements have been established in these areas. The systems involve improved navigation, communications, optical and electronic reconnaissance, weather surveillance, geodetics, and satellite detection. Some of these areas of naval interest may overlap those of the other services.

This chart on the bulkhead to my right shows this quite clearly (fig. 79).

In the left where the checkmarks are you see, opposite combat systems, where each of the services has an interest in those specific systems, and the circles to the right in red under the various reconnaissance systems shows those in which each of the services may have a distinct interest in the specific space system.

I think it is probably quite clear. We are trying to show here that each of the services has an interest in practically all of the space systems that we have today in the military.

This duality of interest does not in itself necessarily imply duplication. Compatibility with a specific weapon system may demand that a space system be designed by a particular service even though the system is in an area which parallels the interests of another service.

The aircraft designed by the Navy for use on its aircraft carriers is an example of development which has necessarily paralleled that of the other services. The reconnaissance satellite designed by the Army or Air Force for the close observation of specific land areas would not necessarily fulfill the requirements of the Navy for surveillance of shipping in the worldwide ocean areas.

The fact, however, that there are overlapping interests does point up the need for the closest coordination and joint effort between services in the development of their space systems.

SPACE SYSTEMS

COMBAT SYSTEMS	ARMY	NAVY	AIR FORCE	WEATHER	GEODETIC	COMMUNICATIONS	NAVIGATION	OPTICAL & INFRA RED RECONNAISANCE	INFRA RED EARLY WARNING	PASSIVE ELECTRONIC COUNTERMEASURES	SPACE SURVEILLANCE
STRAC	✓			●		●		●	●	●	●
DEPLOYED ARMIES	✓			●		●		●	●	●	●
AMPHIB	✓	✓		●		●	●	●	●	●	●
CARRIER STRIKE		✓		●	●	●	●	●	●	●	●
POLARIS FBM		✓		●	●	●	●	●	●		●
ASW		✓		●		●	●	●	●	●	●
MINE WARFARE		✓	✓	●		●	●	●	●		●
AIR DEFENSE	✓	✓	✓	●		●		●	●		●
MISSILE DEFENSE	✓	✓	✓			●		●	●		●
TACTICAL AIR SUPPORT	✓	✓	✓	●		●		●	●	●	●
STRATEGIC AIR			✓	●	●	●	●	●	●	●	●
ICBM			✓	●	●	●		●	●		●
IRBM			✓	●	●	●		●	●		●

✓ COMBAT SYSTEM PECULIAR TO A SERVICE

● SPACE SYSTEM WHICH CAN BE EMPLOYED EFFECTIVELY BY THE INDIVIDUAL SPACE SYSTEM

FIGURE 79

The overlapping interests of the various military weapons systems is illustrated on this chart. The Navy view is that an organization is needed to provide effective participation by all combatant services in the military effort to include operational planning, launching, tracking, data handling, and read-out, and where necessary, the recovery of the various space systems. Such an organization must be able to insure that the specialized operational requirements of each of the combatant services are fulfilled. It could insure that duplication of effort is minimized, and that the overall military space effort is performed in the most efficient manner.

A Navy space facility that is of significance at this time is the Navy space surveillance system, centered at Dahlgren, Va. This Navy facility has been detecting and cataloging all orbital objects passing over the United States since February, a year ago, whether or not they are emitting electronic signals.

The Navy's Space Surveillance Center at Dahlgren, Va., using a large computer regularly compiles and disseminates to the military and civilian users, orbital data on all satellites. The Navy considers space surveillance information vital to the security of our fleet forces when considered in the light of the demonstrated Soviet capability in space photography.

The surveillance center is, therefore, tied in with our forces afloat and regularly disseminates to them orbital data on foreign satellites. This permits fleet forces to develop effective countermeasures and evasive tactics, and to train our personnel in the military use of such information.

The space system that we believe will soon be operational is the navigation satellite, Project Transit. From an operational standpoint, we consider that this system will be in fleet use by 1962. Moreover, the research and development models to be placed in orbit this year may prove operationally useful. In anticipation of its operational status, we are planning to equip our ships and train personnel in its use. The operational effectiveness of the system should greatly improve the accuracy of the fleet ballistic missile. It will likewise contribute significantly to the effectiveness of our attack carrier and antisubmarine operations.

Now, in the field of space support functions, the Navy has resources, facilities, and forces to contribute:

1. Resources consist of:
   - (*a*) Trained personnel.
   - (*b*) Test, and evaluation activities:
     - (1) Naval Air Development Center.
     - (2) Naval Research Laboratory.
     - (3) Naval Ordnance Test Station.
     - (4) Naval Electronics Laboratory.
     - (5) Aviation School of Medicine.
     - (6) Research programs at various U.S. universities.
2. Facilities consist of:
   - (*a*) Pacific Missile Range.
   - (*b*) Navy space surveillance system.
   - (*c*) Communication facilities.
   - (*d*) Sound location sites.
3. Naval Forces consisting of ships and aircraft units.

The Navy has been actively involved in the recovery of space vehicles and has contributed heavily to space support operations of this type. Our contributions to recovery of the Nation's first space flight capsules of Project Mercury, bespeak of the growing importance of the sea for space operations. So far, the Navy's achievements in this regard include the recovery of a number of nose cones. Three of these recoveries included biomedical capsules containing primates.

The magnitude of the overall support problem is well illustrated by the support which the Navy is providing for Project Mercury. Project Mercury recovery responsibility is assigned Commander Atlantic Missile Range, and Commander in Chief, U.S. Atlantic Fleet, is assigned recovery operations for the Atlantic area.

During 1959, fleet units have developed recovery techniques, procedures and hardware and have provided ship and aircraft support for the solid rocket booster tests which have been conducted by NASA off Wallops Island, Va., as well as the Atlas-boosted tests on the Atlantic Missile Range.

In 1960, the Atlantic Fleet forces will continue development of recovery techniques and will provide ship and aircraft support for the recovery of Redstone-boosted ballistic shots, as well as for a number of Atlas-boosted ballistic shots which lead up to the first Project Mercury orbital shot in late 1960 or early 1961.

Certain Navy resources have contributed to Project Mercury in the form of biomedical equipments, and space simulation devices which the Navy has developed. In addition, the Navy was a source for three and Marines for one of the seven men who were selected as astronauts for Project Mercury.

The Navy has been requested to furnish certain facilities in the Pacific Missile Range to support Project Mercury. These include certain instrumentation for tracking, telemetry, communications, command control, and data reduction.

Additionally, Pacific Missile Range will provide an instrumentation ship to be stationed off the west coast of Mexico for tracking, telemetry, and command.

To assist NASA in the construction of facilities on Canton Island for telemetry in the western Pacific, the Navy is providing a Seabee construction team. The Navy is providing also real estate and local support for the location of a trucking station at the Naval Air Station in Corpus Christi, Tex.

The forces utilized in Project Mercury recovery operations include destroyers, dock-type landing ships, patrol aircraft, helicopters, and fleet oilers. The estimated Navy support force requirements for the entire project approximately 2,245 ship-days and 1,264 aircraft/helicopter-days. In consideration of the importance of the project, and the fact that the eyes of the world will be focused on it, the Navy considers the recovery operation or the astronauts to be of paramount national importance. The Navy is rendering maximum support.

With the increase in tempo of activity of the total national space effort, hard earned experience has shown a definite need for joint participation by the combatant services to support this national space effort.

The effort required to provide transportation, communications, logistic support, and operational facilities, in addition to boosters and payloads for various projects, necessitates the direct participation by

the combatant services in the development of military space technologies.

The CHAIRMAN. Thank you very much, Admiral, for a very fine statement.

Admiral Hayward, do you also have a statement?

Admiral HAYWARD. Yes, sir; I do, Mr. Chairman.

The CHAIRMAN. We would like to have it, Admiral, at this time.

Admiral HAYWARD. All right, sir.

STATEMENT OF VICE ADM. JOHN T. HAYWARD, DEPUTY CHIEF OF NAVAL OPERATIONS FOR DEVELOPMENT

Admiral HAYWARD. Good morning, gentlemen. I am Vice Admiral Hayward, the Deputy Chief of Naval Operations for Development. One of my responsibilities is to ensure that scientific developments are exploited for application in the Navy's conduct of its functions.

For this reason, I would like to direct your attention to the science part of your committee's interests. Although your present concern is primarily directed toward space and astronautics, a brief setting of the stage may help us realize a little better how it all started.

SCIENCE AND SPACE

"Science," which basically means "knowledge," has always been of great concern to the navies of the world. The inherent challenge of warfare at sea, over extended distances, against fleeting enemies has led our Navy to constantly explore new areas, develop new techniques, and pursue advanced research so that we might be able to accomplish our basic mission in new or more efficient ways.

The Navy has explored the Arctic regions, developed rockets, created artificial environments for human beings, investigated the upper atmosphere, searched the ocean's floor, frozen human tissue, explored the atom, and even analyzed the atmospheres of the other planets. This pursuit of science, this reaching for knowledge has been necessary for the development of the submarine, operations in the polar regions, transmission of naval communication, perfection of guided missiles, and conduct of antisubmarine warfare.

In this process of reaching out to new horizons, the Navy recognized very early the scientific challenge of outer space—that great unknown that surrounds us. The proposals in 1946 and 1955 for Earth-orbiting satellites were directed toward exploration of this new medium. The strato-lab carried by balloons to high altitudes, the rocket probes that sampled the upper atmosphere, or the radar signals bounced off the moon were all part of this reaching for knowledge, the pursuit of science.

Now this does not imply that the Navy laid claim to the upper atmosphere, to radar, or to space. We wanted to find out how we could exploit these techniques, these areas, or these media for Navy purposes, to better accomplish our job.

SUPPORT TO NATIONAL PROGRAM

Other activities and agencies were also so involved, and whenever a clear responsibility developed, the agency with primary cognizance naturally turned to the Navy for support or assistance.

The Atomic Energy Commission has used quite a bit of our research. With the creation of the National Aeronautics and Space Administration, the primary responsibility for space exploration logically developed on that organization.

The Vanguard project, being a scientific endeavor, was transferred to NASA from the Naval Research Laboratory, which had developed this IGY contribution. The benefits to all other space programs in the form of components, techniques, power sources, tracking facilities, and boosters have been numerous.

Although the post-sputnik furor confused the understanding both in its objectives and in its contributions to space programs. Similarly, the Navy has provided valuable support to NASA for development of solid boosters, passive communication satellites, and for the NASA weather satellite.

We do not consider these functions to be competitive to Navy functions, but rather feel that they are bonuses that have evolved from the Navy's basic search for better ways to do its job. At present we are not certain of the naval uses for a man in space, but are pleased to be able to support the civil program toward that goal which is so vital to national prestige.

As Admiral Pirie pointed out, these contributions to the national effort are largely unrecognized by the public because we do not publicize what we considered to be the fact of merely doing our job. In the NASA Mercury project, for example, of course, the Navy has contributed men, provided the suit they will wear, administered the contract for construction of the capsule, developed tracking stations, built facilities, provided liaison, provided personnel training, contributed environmental and acceleration research, determined recovery techniques, and provided some personnel for administration of the program. It is not a Navy program, though such a list may give that impression.

This is an example of how we gladly and willingly can support the civil programs if we are not restricted from doing so. This type of support to the national effort is one of the three ways in which the Navy participates in space activity.

PARTICIPATION IN DEFENSE PROGRAM

The second type of Navy activity in space is its participation with the other services in military space projects. This comprises not only supporting research sponsored by the Department of Defense, but includes participation in satellite programs designed to meet military requirements.

The Navy's contributions to the military space program have been a direct result of the research and development that was directed toward meeting naval needs. Our bureaus and laboratories have been working for many years on propellants, engines, rockets, radars, vehicle stabilization, guidance, sensors, atmospheric heating, missile detection, and similar problems. That research which can be used to support space technology is now contributing to, and frequently being supported by, the Department of Defense scientific effort.

NAVAL PURSUITS

We have not, however, ceased looking for new or better ways to do our job, and so the search includes investigation of space techniques.

This, then, is the third method of Navy participation in space—The pursuit of space techniques peculiar to naval needs. By analyzing and studying the advantages and threats posed by the advancing technology of space, we can determine which of these must, or should be, tailored to specific naval uses.

CURRENT PROGRAMS

Before discussing specific Navy programs, which you will note are neither large in number nor spectacular in the ordinary sense, I would like to explain an important point of view. The advent of space as an area of operations had not changed the basic naval missions which are all related to seapower and our control of the seas. We do not recognize at this time any space-based weapon system which can effectively accomplish the Navy task of destroying hostile naval elements—the surface, subsurface, and airborne forces.

Space techniques for the destruction of land-based threats to our fleets or to the Nation are also remote possibilities. We believe very strongly, however, that space-oriented support systems may soon augment existing weapon systems or alleviate major command problems. These support systems are in the field of satellite navigational systems, communications, and meteorology, and reconnaissance.

In these fields we have a keen interest; these systems comprise our immediate goals. In the future, we feel that technological developments can make possible the definition of space weapon systems which may revolutionize current concepts of war. As in the past, we will continue to develop future weapon systems for the support of our naval missions.

In the category of specific programs, I have available detailed presentations which I will be pleased to present if the committee desires. As a preliminary to this, however, I would like to cover the highlights of the various current programs.

TRANSIT

Our navigational satellite system, Transit, is being developed to provide initially a worldwide, all-weather navigation system capable of extremely high accuracy for use by submarines and surface ships. Extensions of the program are being considered to make the system also usable by aircraft.

Briefly, the operational system will consist of four satellites in circular orbits such that complete global coverage will result.

The orbital parameters of these satellites will be precisely determined by tracking stations which will feed the information to our computing center at Dahlgren, Va.

This project was started about a year ago under the sponsorship of the Advanced Research Projects Agency. Ultimately, however, the Navy must assume the responsibility for providing for both the payloads and the boosters which will be required to place the system into operation. Our present schedule calls for the system to be operational in fiscal year 1962.

Why are we pushing this program? Simply because ships at sea, particularly our Polaris-type submarines, require the best and most precise navigation that we can provide. Transit offers a means of

obtaining an improvement over existing navigational methods at lower cost and with greater coverage.

Additionally, it eliminates our dependence upon fixed transmitting stations located outside the United States which might be highly vulnerable in a war or emergency situation.

Now, I would like to make it clear that Transit wasn't started as a "space for space sake" project, but rather because a space-oriented system appears to offer the best means of obtaining an improvement over existing systems. An attractive gain in efficiency for doing a necessary job appears to be in the offing, and we intend to take full advantage of it; the fact that the system involves space does not mean that it is a glamour project for prestige. It must compete financially and in efficiency with other systems or we cannot justify its use.

SPASUR

Another "space" system developed by the Navy was the direct result of the Navy's creation of the minitrack network for Project Vanguard. After the Sputniks were launched, it was evident that the United States had no means of detecting noncooperating satellites, that is, those which did not transmit on the frequency of our tracking stations, or did not transmit at all.

In June of 1958 the Director of ARPA requested the Naval Research Laboratory to develop a space surveillance system which had the capability of detecting, tracking, identifying and determining the orbit of nonradiating space objects. In response to this request, the Naval Research Laboratory developed the Spasur system, sometimes called the Dark Fence. The system consisted of a data acquisition network, a Spasur operation center, and a computational facility. Feasibility was demonstrated in July 1958, and the complete facility system was placed in operation in August 1959. This system consists of six stations in two groups, eastern and western. Each complex consists of two receiver stations separated by 500 nautical miles with a CW transmitter located between the two which is an old physics means of determining velocities.

The performance to date has exceeded the original expectations by an appreciable margin. The reliability of the equipment has been such that the down-time per month is usually less than 1 hour. No Discoverer satellite has been able to pass through the detection barrier without being detected by one or more stations. The prediction accuracy has been demonstrated by predicting the position of Sputnik III as far as 25 days into the future with the actual observations agreeing within 5 seconds of the predicted positions.

The addition of a second detection zone, standing along a great circle from Miami to Nome, would improve the response time of the system so that after a single passage of a satellite through both detection lines, an orbit could be determined and a warning issued to operating forces in the predicted path of the satellite within 1 minute of the passage. Predictions of the sputnik orbits are now being regularly transmitted to the operating fleets to familiarize them with the plotting procedures, predication methods, and counter actions that are necessary against an unfriendly reconnaissance satellite.

Although this is a ground system, it has important space applications, as you can see.

The Department of Defense is currently considering the establishment of the third transmitter near Wichita Falls, Tex., to close the gap which now exists in the central part of the detection network. The 500-kilowatt transmitter requested will increase the range capability of the detection system to approximately triple the present altitude in addition to completing the coverage in the detection zone. This decision is being delayed pending policy decisions by the Secretary of Defense.

COMMUNICATIONS

In addition to Spasur and Transit, which the Navy is developing for the Defense Department, we are also vitally interested in the area of space communications. The advent of artificial satellites and associated space technology can revolutionize military long distance radio. Our communications of the future will be accomplished or supplemented by space relays—active satellite relays (delayed and real time); passive satellite reflectors (natural, such as the moon, and artificial); chaff belts, or any material orbiting in space which can serve as a reflector. Advantages which can be expected from the use of space technology for communications include broadening of the usable electromagnetic spectrum for radio communications over long distances; freedom from the vagaries of sky wave propagation of high frequency radio transmissions; worldwide coverage; less susceptibility to enemy jamming and intercept; and freedom from political implications of base rights.

Naval communications over long ranges which might be met by communication satellite relay systems are of several types: fixed point-to-point communications; communications between mobile units; communications between mobile units and shore facilities; and broadcast communications to water-borne units.

The Navy research and development program for communication satellites includes feasibility tests of high altitude satellites as relays between ship and shore stations; extension of the Navy's program of radio communications by Moon relay; investigation of systems for polar communication coverage; and concentrated efforts toward communications with submerged submarines.

As a participant in the current Department of Defense communications satellite programs, we have proposed that a Navy ship be instrumented with a complete receiving and transmitting terminal configured for experiments in communications by satellite relay. The experimental shipboard terminal is intended for use with the Department of Defense 24-hour satellite system. Further, it is planned that this installation be flexible enough to serve as a shipborne terminal for experiments with ship/shore moon relay, passive artificial satellites, or chaff in orbit. The 24-hour satellite system promises to meet many of the long range radio communications requirements of the Navy.

Since the development of the special shipboard antenna involved the longest leadtime, and must be meshed with the satellite time scale, ARPA has been requested to provide funding assistance initially with Navy research, development, test, and evaluation funding to follow in fiscal year 1961.

However, it should be mentioned that a satellite microwave radio relay system does not meet the very important requirement to im-

prove communications to a completely submerged submarine. This is an area wherein the Navy will have to pursue space research toward satisfying a need that is not common to the other services.

WEATHER SATELLITE

The need for improved weather information, on the other hand, is common to the military and civil agencies. The weather satellite requirements of the various departments have recently been consolidated to provide guidance to NASA in the execution of its Tiros project. It is not an easy task to satisfy the many diverse needs of the various customers, even though they are all in favor of better weather information.

The Weather Bureau may be looking for long-term weather information for scientific study; some military services are seeking leads to better forecasting for land areas; and the Navy is primarily seeking operation weather information in places where no one else is particularly interested. We believe that a weather satellite can help us obtain weather information in such areas of the world which are either very remote or which could be devoid of information in wartime. We stress the importance of rapid availability of the data from such a satellite, because we feel that naval forces must use weather tactically to maximum advantage.

One very important future application is the use of cloud cover information, from a satellite, as a defense against an unfriendly reconnaissance satellite.

The Navy is participating in Project Tiros, the weather satellite project originally established in the Department of Defense. Since the transfer of this project to NASA, the Navy is continuing its support through the Naval Photographic Interpretation Center which will perform the precision development and photogrammetric analysis of the master photographic record taken by the satellite. Although the Tiros project of two satellites will probably be succeeded by a follow-in program, Nimbus, the total number of weather satellites will still be relatively few.

PROBES

The Navy has tried another technique for obtaining local weather information by means of rockets which are fired in an almost vertical path above the earth's surface. Project Huga has demonstrated the feasibility of obtaining photographs over an area of about 3 million square miles by recovering the payload from such a vertical probe.

Of course, rockets of this sort have been used for many years to sample the upper atmosphere, to determine intensity of cosmic radiation, and to conduct numerous scientific experiments. There are further applications of mapping or communications relay and reconnaissance, which are under study to afford tactical vehicles to perform, at very low cost, some of the tasks envisioned for satellites.

SUPPORTING RESEARCH

This type of vehicle, and the others I have mentioned, can be rather easily identified as space systems which will assist the Navy in accom-

plishing its mission. They are the eventual results of the basic research, or the "pursuit of science," that the Navy supports.

Between that basic research and the development of systems lies an area which we can call supporting research. It is the area in which we pursue with definite intent the results that basic research has generated.

Though not identified as systems, supporting research is directed toward improvement of our space technology. Areas such as solid propellants, materials, biomedical research, and boosters will certainly yield benefits in many fields in addition to space. They are being pursued vigorously because demands of space techniques require that the greatest advancements possible be made in the state of the art in these areas.

Our efforts in astrophysics, radio astronomy, investigation of cosmic radiation, and high altitude rocket soundings of the upper atmosphere are being undertaken in order to learn more of the nature of outer space. These are necessary preludes, not only for manned space travel, but also for the more immediate applications of unmanned space vehicles. In addition to research for satellite applications of communications, navigation, reconnaissance and antisubmarine warfare, we are also attempting improvement of satellite payloads to afford greater efficiency, smaller size, and greater reliability. Supporting research covers a broad area; even such undertakings as improvement of mathematical computers or facilities for data handling are very closely related to our ability to use the information we get from satellites.

Space vehicles, of course, are not the only way we can use space, because other phenomena such as ionization in the upper atmosphere or entrapment of free electrons may possibly be used for detection of ballistic missiles or the jamming of radio transmissions. These are also space applications, and are typical of the diverse areas that our supporting research investigates.

In our approach we have kept in close touch with the space research and development efforts of other agencies. We have contributed to them where we could, we have sought to learn from others wherever possible, and we have done our best to avoid expensive duplication of the efforts of others.

We are, therefore, confident that the Navy has given this Nation the very most in actual space progress for every space dollar expended. We are confident that we can continue to do so, because that is how we are trained and organized to conduct our business.

FUTURE PLANS

Operational space systems are truly the responsibility of the military services, and if we want to use these advanced systems, we must make preparations now. We have great hopes for Transit, of course, and are prepared to assume the operating costs of this system for the advantages that it will afford.

We also plan to extend the Spasur system both in coverage and in speed of data transmission to the fleets so that we can minimize any threat from an enemy reconnaissance satellite. We wish to extend our present capabilities for surveillance through use of tactical probes and satellites. The first Earth orbiting vehicles capable of yielding worth-

while military information will probably be large, complex, and, unfortunately, costly.

They also will require extensive and complex systems for making available to the user the data they have acquired. We envision that refinements of payloads and improvements in propellants can afford us reduction in satellite size so that we can gain true flexibility in satellite operations.

Scout, which is under consideration as a booster for Transit, points the way for inexpensive boosters that could be launched from ships at sea anywhere in the world.

One type of launching that very obviously should be accomplished at sea is that of launching the super boosters which will be required for space travel. The complex launching platform for such vehicles is not consistent with the Navy's desire for mobility and speed.

The technology, however, is one in which the Navy excels. If the Nation is to realize the many advantages of sea launch, the Navy is willing to provide to NASA the know-how for launching the superboosters. Their size will necessitate all the familiar techniques of construction movement and support that the Navy has provided for ships.

If we develop a fully nuclear booster, the sea will afford the only safe launching area.

Beyond these foreseeable applications of space lies a great area of promise which is filled with many unknowns. We feel that NASA's exploration of space will yield many answers that are now uncertain. Manned space platforms, lunar bases, and military forces on Mars are subjects for interesting conjecture, but we prefer to be cautious in our dreaming with dollars at this time.

The Navy is certainly visionary, but we do not have the hallucinations of some space addicts.

Desire or hopes does not necessarily mean that an avid pursuit of a dream is always justified. Basic research is essential. Investigation of discoveries is mandatory. Development of systems must be accomplished after these vital steps have justified the further pursuit of a promising technique. This the Navy believes. We will do our homework, set our goals, and exploit space for the benefit of the Navy and the Nation. This is the underlying theme of the Navy's effort in space.

Mr. Chairman, I would like to show the committee here—we have what is known as the Spascore. It is an essential step in trying to get the human mind to comprehend the space situation when the population in space is large. Now, this concept is developed as an essential step for operational people, of course. The system can show the past, present and future position or paths of any satellite, group of satellites, or all satellites contained in the space catalog. It can also show the predictive reentry point of any satellite approaching the final phases of its life.

The Spascore system can also be programed to show the impact point of a satellite subject to a predetermined reentry maneuver as planned in the Mercury program.

Now, this system works on relatively small frame rate. It is a very small scale portrayal of the earth's surface. The apparent motion of the satellites between the frames of this scale is quite small. As

soon as the operational use of this concept has been determined, changes undoubtedly will appear. It is very likely that the scale is too small, the frame rate may have to be increased, it is probable its specific areas should be viewed at an expanded scale.

It is also probable that an instantaneous presentation rather than a delayed presentation using advanced satellite predictions may be required.

As soon as the operational user becomes used to this system, I am sure new ideas will be brought into the development.

As the committee, I am sure, is familiar with the number of satellites in orbit right at the moment, Captain Berg, here, will give you a short rundown on this system, Mr. Chairman.

STATEMENT OF CAPT. WINFRED E. BERG, USN, PROJECT OFFICER, NAVY SPACE SURVEILLANCE SYSTEM

Captain BERG. I think if you turn the light out, you might be able to see it a little bit better.

Each one of these dots shows the present position of one of our existing satellites. I am sure you can't see it from over there, but when you come a little closer later on, there is a line of dots trailing each one of the main dots. This represents the past position of each satellite or rather, a track, the way it is proceeding.

Now, the next shot you will see that the spot moves just a little bit. In one minute, one of these satellites will move approximately 300 miles. So you can see that on this small-scale map it represents a very small distance.

Now down here we have the instantaneous altitude of each one of the satellites which changes with each frame. And then we give the exact time of this particular presentation.

Do you want to turn it on, please? This speeds it up which will show you exactly the track these satellites are meeting. This is speeded up to a speed of 240 times as fast as the real motion. Do you see the motion here [indicating]?

Admiral HAYWARD. You can see, Mr. Chairman, when the space gets full of a lot of these things, you have quite a problem.

I have, Mr. Chairman, with me Captain Berg, and also Dr. Kershner on a presentation of these other systems, but I would rather give those systems in closed session.

In open session we have sanitized versions of it, but I think it would be better for the committee to do this at a later date.

The CHAIRMAN. Admiral, we want to thank you very much for your statement.

Now, before going into the questioning, the Chair would like to bring up this request which our staff made of the Navy regarding the use of the naval weapons plant. Mr. Lankford, from Maryland, who asked us to make the request, is here. Do you have any statement, Admiral, that you would care to make at this time in reference to the future use of that plant?

Admiral HAYWARD. Mr. Chairman, I don't have a statement to make on it. I know this is under consideration. We have gone to NASA. Admiral Stroup, who is the Chief of the Bureau of Weapons, is following this particular subject and would be available to discuss it, I am sure.

I am sorry you didn't get into it with the Secretary yesterday. It has been handled at the Secretary's level with the Chief of the Bureau of Naval Weapons and both sides, the House and the Senate, have asked about it. I know we are doing some NASA work there, not an awful lot. But they are preparing to answer these questions.

The CHAIRMAN. Mr. Lankford is here. Do you care to make a short statement, Mr. Lankford?

Mr. LANKFORD. Thank you very much, Mr. Chairman.

STATEMENT OF HON. RICHARD E. LANKFORD, REPRESENTATIVE IN CONGRESS, STATE OF MARYLAND

Mr. LANKFORD. Thank you very much, Mr. Chairman. I appreciate this opportunity greatly. In your statement, Admiral, you were talking about areas such as solid propellants and materials, then a little further down, greater reliability. I suppose you were talking of materials there.

It seems to me that we have skills at the naval weapons plant that are hard to find, and it has been my firm conviction, and until I am proved wrong, it is still my conviction, that these skills and this great plant we have there can be put to good use in these programs of yours.

I would certainly hope that the Navy Department, in conjunction with NASA, would investigate this to the fullest and I would hope that these skills which we have there will not be lost to the defense system, to the defense of the country.

I am convinced that they can be utilized and can be utilized economically. You said that you had no particular knowledge of this other than a general knowledge that Admiral Stroup and the Secretary had this under advisement. So I don't believe, Mr. Chairman, that any purpose would be served by pursuing it further at this time.

The CHAIRMAN. Thank you, Mr. Lankford.

Mr. LANKFORD. Thank you very much, sir.

The CHAIRMAN. Now, the Chair will state this, that when we do get a report, if the matter requires further committee effort, why it is our purpose to send it to a subcommittee to handle the matter. But the Navy, like all of the services in all parts of the country, is reducing installations, and it is difficult—as I am sure the people in the District area know—to find a need for everything that was built in prior times and has been useful in war efforts or in times of semi-war.

May I ask you, Admiral Hayward, a question or two in reference to your statement? I thought your statement was an excellent statement. It had vision to it and it had imagination to it and yet was thoroughly practical.

You testified last year, Admiral, that the Navy needed more money for basic research and for component development.

Under the fiscal 1961 budget, will this situation be improved?

Admiral HAYWARD. No, sir; it will not be improved, Mr. Chairman.

The CHAIRMAN. What are the dollar amounts for 1960 and 1961?

Admiral HAYWARD. I can furnish—roughly in 1961 the money for the Office of Naval Research is about $92 million, versus $104 million in 1960. I can furnish the exact numbers into the record, Mr. Chairman. It is down in the research and development area.

The CHAIRMAN. You can give us the exact amount for the record.

Admiral HAYWARD. Yes, sir; I can. Our funding for fiscal year 1960, $99,030,000; fiscal year 1961, $92,162,000.

The CHAIRMAN. Now, Admiral, I would like to ask you this: You are a member of the NASA civilian-military liaison committee. In your opinion, has that committee worked effectively?

Admiral HAYWARD. Mr. Chairman, I started out as a member of that and then we appointed Admiral Pirie. He was appointed as the member with Admiral Masterson as the alternate.

Admiral Masterson is our Director of Guided Missiles, who works in the research and development area.

The CHAIRMAN. Maybe Admiral Pirie can answer that question.

Admiral HAYWARD. Yes.

Admiral PIRIE. Yes, Mr. Chairman.

I would say that the civilian-military liaison committee of NASA has not been as effective as it might have been. I don't think that it was used either by the Department of Defense or the National Aeronautics and Space Administration as much as it should have been used.

The CHAIRMAN. Do you think the coordination of the civilian and military space programs would be improved if they left it to ordinary interagency cooperation?

Admiral PIRIE. It is my opinion that you need a coordinating machinery between NASA and the Department of Defense in the space area to really have an effective interchange of information and to prevent duplication. I do not think that it can be as effectively accomplished without a body and the machinery to do it as it would be if such a body existed.

The CHAIRMAN. What are the weaknesses of the present system?

Admiral PIRIE. I presume you mean the National Aeronautics and Space Act as it is now written?

The CHAIRMAN. That is right; yes, sir.

Admiral PIRIE. I don't think there are really any weaknesses to the system. I think it depends on the way it is operated.

The CHAIRMAN. Well, do you mean the law is good but the execution is bad? Is that in effect what you mean?

Admiral PIRIE. Well, in effect; yes, sir.

The CHAIRMAN. Well, in what respect has it fallen down?

Admiral PIRIE. Well, there are two bodies that have not been used effectively that were set up within the law. One is the Space Council, and the other is the Civilian-Military Liaison Committee.

The CHAIRMAN. You feel that the Space Council should have been used and it has been overlooked?

Admiral PIRIE. Well I think that is a little out of my purview and not a part of my particular business.

The CHAIRMAN. Well, is the other——

Admiral PIRIE. The CMLC; I, as a member, sat on that from its inception.

The CHAIRMAN. And what——

Admiral PIRIE. And it has not been used to any great extent. Very few problems were presented to us to solve. It was used as an information agency, principally, and I think that it could have been used more effectively. I would like to say, however, that there were a great many things done at the member level between the National

Aeronautics and Space Administration and the Department of Defense members that did not appear on the surface, such as problems in personnel coordination and in obtaining personnel for the agency—the support for Project Mercury, as an example, where we went to work and were actually picking up the capsules and learning that art within a week or two of the time that we were told that they wanted us to do it, without any fanfare or fuss. In these areas we have been effective.

The CHAIRMAN. We have lost a good deal by not using it, then; is that your answer?

Admiral PIRIE. In my opinion, it could have been used more effectively if used in practically all areas at the top.

I do not think you can, by just words of "advise and consult," make a really effective system. I think that you have to have a machinery setup within the law that is effective and will work in order to get proper coordination.

The CHAIRMAN. Mr. McCormack?

Mr. MCCORMACK. Well, what you are telling us is that the human aspects of it have not been doing the functioning they are capable of doing under the law.

Admiral PIRIE. That is right; yes, sir.

Mr. MCCORMACK. Would you recommend that this Committee be retained in the law in the hope that its significance might be recognized?

Admiral PIRIE. It is my own opinion, Mr. McCormack, that some coordinating machinery at this level would be much more effective than not having it.

Mr. MCCORMACK. You are a member representing the Navy—I do not want to get into the critical stage; in fact, we just want to see how we can improve. Would you say that as an official member you are in a much better position than if the Committee did not exist because you can make some inquiry which you might hesitate to do if you did not have this Committee?

Admiral PIRIE. I might say that there must be some point of contact within the Department of Defense, certainly, if you abolish the Committee for the National Aeronautics and Space Administration, to work.

Mr. MCCORMACK. And also for NASA, too?

Admiral PIRIE. For a mutual exchange of information and technical details, and the machinery set up to exchange this information and technical detail and to prevent duplication.

Mr. MCCORMACK. In other words, such a committee would be of vital importance in connection with the maximum contribution both to the defense of our country and to the pursuits on the peaceful side, and at the same time prevent unnecessary expenditures of money, duplication, and so forth.

Admiral PIRIE. I would say so; yes.

Mr. MCCORMACK. Admiral Hayward, on page 13 of your statement you were referring to the space system, you said about data transmission to fleets, "so that we can minimize any threat from any enemy reconnaissance satellite." Would you give the committee some information about what those satellites could be?

Admiral HAYWARD. For instance, if you had a satellite up there that wanted to get electronic intelligence from you, it is interested

in pulse width, repetition rate, things of this kind, and if you knew where it was and when it was coming, if you shut everything off, why you might take active countermeasures to give him the wrong information, too. But the ability to know where these things are is of vital importance to all of us, really. This is what we are thinking of.

Admittedly the sensor, the state of the art of sensors of looking down and seeing things or getting this information is at a point now where you cannot get all you want. I mean you could not today put something up and really get the resolution that you require to get the information. You can get electromagnetic spectrum and you can get the infrared spectrum, but to take real fine pictures or things of this kind, this would be real difficult.

Mr. McCormack. I imagine, I would assume that great importance is attached to this activity?

Admiral Hayward. Yes, sir; which brings in another type of satellite. You see, everybody gets real interested in going into deep space and all that, but we have something which is known as a satelloid, which is something that returns to the Earth. It goes around a couple of times and comes back.

Now, if you can recover it, then you can really process pictures and things of this kind. This technique means that maybe you will go around only 100 miles high and only go around for a definite orbit, but this would permit you to do better work in this particular field, rather than trying to convert something to an electronic image, transmitting it, reconverting it back to a picture. You probably saw the photographs of the Moon and how they were touched up and things of this kind. The resolution is a tremendous problem in any of these devices. But this is where the military has a very prime interest which is to use, let us say, close-in space to get all the information we can. We feel it would be very useful to a shipboard or fleet commander to be able to air-launch a satellite or satelloid that goes around the Earth a couple of times but goes over areas he wants to know about either for weather or reconnaissance and that he gets it back.

Now this is one of those questions of what the state of the art is. If you get it back, as you have seen the pictures of the separation of the Thor, things of this kind, these were all photographs that were recovered, you see. And this is why they were as good as they were.

Mr. McCormack. Were you talking about any enemy reconnaissance satellite?

Admiral Hayward. Yes, sir.

Mr. McCormack. Give us an idea of what an enemy reconnaissance satellite——

Admiral Hayward. I feel they would be much more inclined to go after communication intelligence and electronic intelligence rather than take photographs of the United States. You can buy Aviation Week and anything else. We do not have any secrets.

Mr. McCormack. We will strike out the word "reconnaissance" and let us confine it to satellites. Would you include in that the possibility of satellites, say, within 200 or 300 miles of the Earth's orbit that might be able to fire, discharge with precision a powerful weapon?

Admiral Hayward. No, sir; I think this is in the realm of pretty good space dreams at the moment.

Mr. McCormack. You mean what I just asked you?

Admiral Hayward. Yes, sir.

This is a real difficult problem. As you know, Newton's law of celestial mechanics, it would be real difficult to do this and it would be the hard way to do it. You can go from any point on the Earth to any other point on the Earth relatively easy rather than putting something up in orbit and then trying to shoot it back down at the Earth. There are easier ways to do it. Before the enemy would do something like that, he has competition in his systems, I am sure, and the Russians always seem to take the simple approach—he would use a simpler way of doing it than that. Their satellites could be used to try and get the distribution of where our forces were, trying to get all sorts of communication intelligence and electronic intelligence, as the primary use of this. I do not know whether he would put up a warning satellite such as the Midas. He might, I do not know.

Mr. McCormack. You have less money next fiscal year than you have this year?

Admiral Hayward. Oh; yes, sir.

Mr. McCormack. Does that mean you have to scrap some—that among those projects, both research and development, that you consider to occupy a preferential status you have to lay some on the table?

Admiral Hayward. That is true, we have. All of our areas and systems are down this year from what we had last year. The total—I can give you some examples. In 1960 we had $33 million for instance in electronics system. This year we have $31 million, in 1961.

Mr. McCormack. At an increased cost?

Admiral Hayward. That is right. The effort is down, Mr. McCormack. There is no sense arguing about that. Even if you kept it at a level dollar it would be down, but actually it is down in dollar effect in a lot of the areas.

Mr. McCormack. I will not ask you the next question that I might be prompted to ask you about your opinion as to the policy. So I will not press you.

Admiral Hayward. Well, as you know, Mr. McCormack, I do not make the policy.

Mr. McCormack. About the wisdom of it.

Admiral Hayward. Oh, the wisdom of it?

Mr. McCormack. I will not ask you that question. [Laughter.]

Admiral Hayward. I will not take the fifth amendment.

The Chairman. Will the gentleman yield?

Mr. McCormack. I am through. I will yield to you; yes.

The Chairman. Could you place in the record the other instances? I notice you were——

Admiral Hayward. Yes, sir; I will place the comparison of the 1959, 1960, 1961 budgets for the research and development programs in the record. The comparative research, development, test, and evaluation—new obligational authority—figures are for fiscal year 1959, $1,172,482,000; fiscal year 1960, $1,255,437,000; fiscal year 1961, $1.169 million.

The Chairman. On the individual items. You started out with one example there but you had some other examples?

Admiral Hayward. I do; yes, sir. I have communications down from $6 million to $5 million, and these are in systems; I will place those in the record, Mr. Chairman.

The Chairman. All right. And the amount that they are down.

Admiral Hayward. Yes, sir.

The CHAIRMAN. Mr. Fulton?

Mr. FULTON. I am glad to have both Admiral Pirie and Admiral Hayward here with us because we know they are doing an excellent job, and being a Navy Reserve officer I am glad to be part of the group.

The question comes up, what did the Navy ask for on research and development, overall, compared to what you were allowed by the Bureau of the Budget for the coming fiscal year 1961.

Admiral HAYWARD. Actually, my requirements were $1,543,584,000.

Mr. FULTON. And what did you get?

Admiral HAYWARD. $1,169 million.

Mr. FULTON. And what percent of that that you received from the Bureau of Budget in allowance is that of what you asked?

Admiral HAYWARD. Well, actually, I cannot say the Bureau of the Budget cut this down, Mr. Fulton. The guidelines that were given us and the picture is confused in that they transferred test and evaluation items, such as missiles that come out of the research and development budget now. So it is hard, a direct comparison of the sums is difficult to arrive at.

Before those missiles—for instance when we shot a Polaris or when we shot a Corvus or one of those missiles, those missiles were bought under procurement appropriations. Now they have placed that money in the "Research, development, test, and evaluation" appropriation.

Mr. FULTON. But you are actually short on dollars, $374 million for the year 1961?

Admiral HAYWARD. Yes, sir.

Mr. FULTON. And would you have in mind asking for supplemental appropriations as you went or would this be your final figure? Would you not ask for any further funds?

Admiral HAYWARD. Well, I would ask—in the normal course of business I go to Dr. York for emergency funds.

Mr. FULTON. And last year in the fiscal year 1960, how much extra did you get above the regular budget?

Admiral HAYWARD. Well, they were very kind to me on the last day of the fiscal year, they gave me $30 million, but I could not spend it, of course, on the 30th of June. So it is added to the 1960 program.

Mr. FULTON. 1961 program?

Admiral HAYWARD. No. You see that was on June 30 last year he gave it to us—the emergency funds to the Services—but of course, naturally, I could not spend it. My real problem is in expenditure limitations as much as in the actual new obligational authority. We have an expenditure limitation in 1960 of $1,130 million and I have in 1961 $1,266 million expenditures, a limitation.

Mr. FULTON. Is that on a guideline basis?

Admiral HAYWARD. Yes, sir. That is given us, overall expenditures that the services are allowed to have, and this is what I got out of the pot.

Mr. FULTON. Rather than take the time at this particular point, would you put in the record a statement of what you would like to have for this current fiscal year coming up, beginning July 1, 1960, in addition to what you have already had from the Bureau of the Budget? If you will give me the amount now, you can fill out the various projects later, because I am sure this committee would like to help you.

Admiral HAYWARD. Yes, sir; I will furnish that, Mr. Fulton, with a breakdown showing you the test and evaluation transfers that were made.

Mr. FULTON. That is what I would like.

Admiral HAYWARD. All right, sir.

Comparison of Navy fiscal year 1961 research, development, test, and evaluation requirements budget with congressional submission

	Requirements budget	Congressional budget
Basic research, development, test, and evaluation	$849,974,000	$603,000,000
Polaris	283,800,000	273,800,000
Pacific Missile Range	88,010,000	68,794,000
Comparative test and evaluation transfers	321,800,000	223,406,000
Total	1,543,584,000	1,169,000,000
Difference		−374,584,000

Mr. FULTON. Now, in each of your statements you have emphasized the Mercury program and the part that the Navy is playing in the Mercury program. For example, Admiral Hayward, on page 3 of your statement, you say, you are not certain of the naval use for a man in space but are pleased to be able to support the civil program toward that goal which is so vital to national prestige. And then in Admiral Pirie's statement, page 7, in view of the importance of the project, meaning Mercury, and the fact that the eyes of the world will be focused on it, the Navy considers the recovery operation for the astronauts to be of paramount national importance. The Navy is rendering maximum support. Now, it has been proposed that the Mercury project target dates be postponed 3 to 5 years on the basis that this was not the kind of a project that should be given a DX, or the highest national priority. Do you agree, and if not, why not?

Admiral HAYWARD. I think the Mercury project is very important, Mr. Fulton.

Mr. FULTON. You do not think the target date should be postponed? I certainly do not.

Admiral HAYWARD. I do not know who said this.

Mr. FULTON. But you disagree with that position?

Admiral HAYWARD. If anybody says it should be postponed, I do not believe this myself.

Mr. FULTON. Do you not think that Project Mercury is a necessary step in space for both the civilian and the military or security approach to space? I do and I am very sincere in wanting the Mercury project pushed at every speed and that is why I call attention to your two statements

Admiral HAYWARD. My point is that I cannot tell you any military system that it will be used in, but it has great military potential. So certainly we would be foolish not to explore it. Of course the big problem always comes: Where is space? The F–4H at 90,000 feet, is that space or does he go to 500,000? Now the X–15 is going to be the same sort of a problem. I think we have got to find out all we can about this.

Mr. FULTON. I do, too. Admiral Pirie, would you comment.

Admiral PIRIE. I would say any delay in the program set out by the NASA is a problem within their purview and they know more about it than anyone else.

Mr. FULTON. But you feel that man in space and maneuverable instruments or vehicles in space are certainly of great military potential and should not be postponed?

Admiral PIRIE. Most important to us.

Mr. FULTON. Now I want to compliment you. The Air Force had come in with a word "aerospace," which is their jurisdiction. I want to compliment you on not coming in with "mari-aerospace." [Laughter.]

You are saying that you do not claim any particular field in space but will be glad to cooperate with both the civil and the military agencies in the national effort in space; that really is a rewarding and very satisfying comment to make.

Now another thing I would like to ask about is on page 3 of the statement of Admiral Pirie. The Navy view is that an organization is needed to provide effective organization by all combat and services in the military. And of course that means space effort.

Now the question then is: Would that be a military joint command for this military purpose; and secondly, it would not be in the sense that General Medaris wants an overall military command for all space; and thirdly, it would be a combination of the various services, such as the Army, the Navy, the Air Corps, the Marine Corps, rather than on the Department of Defense level; and, lastly, would it supersede ARPA, or would it be an additional thing at DOD or the service level? You see, where do you put that in your concept? And that is all, I am through then.

Admiral PIRIE. My comment was made about the organization within the Department of Defense.

Mr. FULTON. At that level?

Admiral PIRIE. At that level, not a national organization as you referred to General Medaris' statement.

Mr. FULTON. So you disagree with General Medaris on that?

Admiral PIRIE. Yes, I think I do, that military should control the whole space effort.

Mr. FULTON. Does this supersede ARPA in your view?

Admiral PIRIE. No. ARPA is now a part of the Office of Defense Department Research and Engineering.

Mr. FULTON. So this is more an operational joint command on planning and carrying out space functions that you would add on rather than replace anything that is there now?

Admiral PIRIE. That is correct. Now this organization, I might say, is up to the Secretary of Defense. He will determine what organization is proper. I do believe that we must, as we go along, have an organization for two reasons: I think that it is necessary that our plans, programs and requirements be coordinated so that we are not duplicating effort, that we know what we are doing in this area and I think that it is also going to be very necessary that we have an organization that coordinates the support effort and that can take charge and run the support effort because we have the resources, facilities and forces to do the job.

Mr. FULTON. But you do not mean to supersede in any way the policy-forming function of the Joint Chiefs nor their directional and operational function, do you?

Admiral PIRIE. No, sir.

Now, this might be a body, whether it is a joint command or agency, it might be under the Joint Chiefs, because a great many of these functions cut across the lines of the unified and specified commanders in the performance of their missions and involves a good many of their forces.

The CHAIRMAN. Thank you, Admiral.

Mr. FULTON. That is all.

The CHAIRMAN. Mr. Anfuso? May I say at this time that Admiral Hayward suggested he had some things to tell the committee in executive session. This afternoon we have two witnesses that we scheduled especially, is that not right?

Mr. BERESFORD. Yes, Mr. Chairman.

The CHAIRMAN. So we would have to hear the Admiral this morning. About how much time would you require in executive session?

Admiral HAYWARD. About 30 minutes.

The CHAIRMAN. If there is no objection, then, I suggest that we hear him in executive session beginning at 11:30 and we take the questions as they come and then, if we have time, we meet at lunch hour to finish up. That would be the only way.

Admiral HAYWARD. All right, sir.

The CHAIRMAN. I think at 2 o'clock we ought to meet with the other witnesses and then we have a special program following the hearing of the other witnesses this afternoon. We have got a rather full schedule.

Mr. BASS. Mr. Chairman, in view of that may I suggest that each one of us from here on have one question to ask.

The CHAIRMAN. What is the pleasure of the committee?

Mr. MOELLER. Move along.

The CHAIRMAN. It has been moved that we go into executive session at 11:30. Is there any objection to that?

Mr. FULTON. Whatever you want.

The CHAIRMAN. I think we should do that. I think in the meantime, Mr. Anfuso, I have already recognized you. From thenceforth every member will be limited to one question.

Mr. ANFUSO. I will try to make it brief.

Mr. FULTON. May I have a unanimous request. I would like to have the chart put in the record following my questioning.

The CHAIRMAN. If there is no objection, it is so ordered.

Mr. ANFUSO. First of all I would like to congratulate Admiral Hayward and to thank him for the wonderful assistance which he gave to this committee at the London Conference and also to take this occasion to thank Captain Berg for his invaluable assistance to me personally on my trip to Moscow; although he got very sick on that trip, he carried on and refused to be bedded.

You said that the effort is down, Admiral Hayward. Can you justify that in the light of information that the Russians are spending a tremendous amount of money on research and development?

Admiral HAYWARD. Well, Mr. Anfuso, you know my position. As we say in Washington there are only two types of people, chiefs and

Indians, and I am an Indian. And we are given guidelines on the budget. I do not know whether you heard the Secretary yesterday and Admiral Burke, but I was given a guideline. There were two of them, there was the 1960 budget plus 10 percent and the 1960 budget less 10 percent. And this was what we had to adhere to.

Mr. ANFUSO. In other words, Admiral Hayward, our military needs are measured in this fashion, you are given a top figure and say: "This is all we are going to spend, now you boys get under that figure." Is that it?

Admiral HAYWARD. Well I do not know who tells the Secretary of Defense, but the Secretary of Defense puts out these guidelines to the budget for us.

Mr. ANFUSO. You do not justify that, though, in view of our national emergency, do you?

Admiral HAYWARD. Personally?

Mr. ANFUSO. Your personal view.

Admiral HAYWARD. No, sir, not at all.

Mr. ANFUSO. Do you have any agreements, Admiral Hayward, with any other countries or are you contemplating any agreements with any other countries that can help you bring about these programs a lot faster? In other words, cooperate with you in these different projects?

Admiral HAYWARD. Well, our mutual weapons development program which has been taken over to the Department of Defense, with General Palmer now, with the MAP, we have 19 projects for instance in Western Europe. We certainly are going to use any of the Western European scientists that we can. Now there are a lot of things that they do in electronics and other basic physical sciences that can help you in space and on the ground and any place, and they are doing real good work for us in all of these fields and they have come along. Our center in Italy at La Spezia is in operation. It is working successfully. Dr. Booth has done a very good job. We certainly intend to pursue that.

Mr. ANFUSO. Admiral Hayward, would you recommend the building of more Polaris submarines?

Admiral HAYWARD. Yes, sir.

The CHAIRMAN. The Chair will recognize Mr. McDonough.

Mr. MCDONOUGH. Will more money correct the failures we have had in our missile and rocket program or is it manpower and brain power that we need more than money?

Admiral HAYWARD. I am just as sensitive as General Schriever. I do not think we have a missile mess or that there are lots of failures. I am real proud of the work that the United States has done and I get real upset when we degrade our performance. I think it is disgraceful to do this, too. When you look at what has been accomplished—most people do not look. Of course, even with due respect to my press friends here, this makes the front page, like last week when the Titan blew up, where was it? It was on the front page. The Polaris went. Where was it? On page 8 with a little paragraph about this big [indicating]. So you do not tell the American people of your accomplishments. We are good. I hate to see us degrade our accomplishments. We have a long way to go, but the Russian is not 10 feet tall and he puts his pants on one leg at a time just like I do and

I get really upset when people say that it is a failure and a mess; it is not. When you look at the satellites right now, what is the satellite that is still broadcasting? It is Vanguard I. Who pioneered the solar batteries? Vanguard I. Where did the spectrograph come from in Sputnik III? Out of the Vanguard. Here we go around with our tail between our legs saying how lousy we are. We are not. They are going to have to come and get me before I say they are as good as they say they are. I get very upset about it.

Mr. McDONOUGH. I think that is a very significant statement. I appreciate it. I hope that makes some of the headlines that you talk about. [Laughter.]

The CHAIRMAN. Mr. Karth?

Mr. KARTH. Admiral, we are good, but we could be a lot better if the guidelines were absent; is that what you are saying?

Admiral HAYWARD. No; I am not saying that. I am sure the administration will make guidelines. We will always have guidelines. Mere money is not the answer to it. You need good people, it gets down to people, it gets down to people like Mr. Hechler was talking about yesterday, educating the young people. It is meeting the challenge. The challenge is not how many ICBM's we have or how many ICBM's they have. The challenge is political, economic, psychological, and military, and it is in peace as well as war and we have to recognize it and we cannot go on saying, "Well, they have 300, we have 200." We assume the Russians can shoot all of these things in a salvo, they all work and they are all going to hit the target. I mean I just feel that we have done ourselves a disservice this way. We can be a lot better and we are going to be better.

Mr. KARTH. I was not referring to that, Admiral. I was referring to the proposition of research and development, I think, which is educational, as Mr. Hechler suggested. If you did not have the guidelines there you could do a better job.

Mr. FULTON. I move we make the admiral an honorary member of this committee.

The CHAIRMAN. We already have a captain on the committee. That is enough brass. [Laughter.]

Mr. FULTON. Touché. We have it on the staff, too.

The CHAIRMAN. Mr. Chenoweth.

Mr. CHENOWETH. Admiral, I also want to commend you for the attitude which you take. I wish all of our people would take that attitude. I deplore this tendency to degrade everything that we have done, to say we have accomplished nothing, and always to hold up in headlines here what the Russians have accomplished. I take it from your remarks that you are not fully satisfied that the Russians are as far ahead of us as they would have us believe in the space and missile program; is that correct?

Admiral HAYWARD. That is correct. I am convinced we are ahead of them in many fields. They are ahead of us in rocket boosters; I have said that here; but because of this we have degraded the rest of our performance. Our technical people are better. Benny Schriever has done an outstanding job; Admiral Raborn has done a tremendous job. Here we have the submarine at sea going and look what Schriever has done. Yet you get all of this playback; I agree we are better than they say we are.

Mr. CHENOWETH. And we are going to stay better.

Admiral HAYWARD. We are going to stay better; yes, sir.

The CHAIRMAN. Mr. Hechler?

Mr. HECHLER. Admiral, just about a year ago when you testified before this committee you were concerned about spelling out the responsiveness of the new space agency to military requirements and you gave the example of the Atomic Energy Commission with the Division of Military Applications as the best way to make sure that military requirements were given adequate attention. In view of what Admiral Pirie has testified about the ineffectiveness of the CMLC I wonder quite seriously what we could do now to make sure that military requirements under the current administrative arrangement are protected.

Admiral HAYWARD. Yes, sir. It was Mr. McCormack over 2 years ago when I brought this up before the legislation was passed. He permitted me to write to him what I thought should be done. That had to do with the Military Liaison Committee. The difference between the Military Liaison Committee and the Atomic Energy and what was set up in legislation here was the fact that under the law the Atomic Energy Commission was required to give its program to the MLC and the Chairman of that body also had the ability to go to the Joint Committee on Atomic Energy. The CMLC—incidentally, the MLC was the Military Liaison Committee. They did not put members of the AEC on that. They just put military people with the Chairman. He could review the entire program of the Atomic Energy Commission. If he did not like it he could do something.

Now we have had no difficulty with duplication with the ordnance side of the business for the AEC, and it was the way the law was written that permitted this to happen. I am convinced in my own mind that we in the Department of Defense are going to have to set up some sort of a Military Liaison Committee, just as General Loper does for the atom, to make sure that not only do we known what their program is, but that we do not get the Bureau of the Budget treatment that I am getting now on a real good example. I can give you a good example on a wind tunnel. This shows you what goes on—now I have a hypervelocity wind tunnel that I want to build out at NOL. We have Dr. Kurzweg, one of the outstanding German scientists. Now I justified this all the way through the military construction program. I had the NASA people come over and say yes, this made good technical sense. It went all the way up to the Bureau of the Budget, then the Bureau of the Budget arbitrarily, when the bill was forwarded to Congress, deleted this on the basis I was duplicating the functions and facilities of NASA.

Now it did not go forward. Now what do I have to do? I had to call and I have to get Mr. Gates to write the Bureau of the Budget. But here is a case where we had thought we had it all the way up and you put the Bureau of the Budget then in the referee business, and he probably will be in the referee business anyway, but technically he tells me I am duplicating the functions. Now if you had had a workable organization at the time in the military and NASA such as the MLC and the AEC, I do not think this would have occurred.

Admiral PIRIE. May I amplify the answer to that question?

The CHAIRMAN. All right, Admiral, and then we are going into executive session.

Admiral PIRIE. The question of getting aeronautical research and development done under the National Aeronautics and Space Administration Act is of some concern to us. Before the act was passed I was a member of the Advisory Committee, National Advisory Committee on Aeronautics which had been in existence for some 40 years. The military fully supported that and we got aeronautical research done by the National Aeronautics and Space Administration to the great benefit of all of the services and of industry and civilization.

There was great concern that because space is so glamorous that a great amount of the effort of this agency would be put on space and that aeronautical research would be neglected. I expressed this at both of the last two meetings of the National Advisory Committee on Aeronautics.

We are more concerned today that that is happening and I would plead with you that if the law is changed that there be some requirements in the law to see that the military requirements in the field of aeronautical research are insured.

Mr. MCCORMACK. May I ask, would you see that appropriate language is submitted for the consideration of the committee.

Admiral HAYWARD. Yes, sir; I will.

The CHAIRMAN. The committee will go into executive session.

(Whereupon, at 11:35 a.m., the committee recessed, to reconvene in executive session.)

(The committee reconvened in open session at 2:04 p.m.)

AFTERNOON SESSION

(The executive session is classified and will not appear here.)

Mr. HECHLER (presiding). The committee will be in order. This afternoon we are going to hear testimony on Project Wagmight. Admiral Coates and Captain Bright of the Navy are ready to testify.

Will you please rise, gentlemen?

Do you solemnly swear that the testimony you will give before this committee on the matters now under consideration will be the truth, the whole truth, and nothing but the truth, so help you God?

Captain BRIGHT. I do.

Admiral COATES. I do.

Mr. HECHLER. Do you have a prepared statement, Captain Bright?

Captain BRIGHT. I do not have a prepared statement. I have a prepared presentation which is "Secret" in classification. I would like to have the opportunity to give it. It describes the Wagmight concept in great detail.

Mr. HECHLER. Is the pleasure of the committee then that we proceed immediately into executive session?

Mr. FULTON. Do you have a sanitized version that you could give us the general picture without getting into any classified or secret material?

Admiral HAYWARD. Maybe I could answer. Of course, I have Mr. Pearson's column on this particular thing. I want to make sure the committee knows——

Mr. FULTON. Is that authoritative?

Admiral HAYWARD. Pretty—well, no comment on that one.

I want to make sure that it is not snarled in redtape. I mean as the program for development for the Navy, it was our decision as to what we did.

Mr. FULTON. I think there should be some public statement.

Admiral HAYWARD. Yes. My statement is that frankly, from a structural point of view, it looked good, but this is an exact example of the things that I told this committee before of trying to go from a concept to a full-blown system.

The proposal that came to me I didn't accept. It was an airfoil proposal. It had to do with something that I didn't feel was going to pay us the dividend we wanted. I felt that this particular material could be used in places, structurally and that we should investigate it as a material, rather than trying to make a complete airplane or anything else out of it at the moment.

Mr. FULTON. So the Navy has an interest in this particular material.

Admiral HAYWARD. Certainly we have an interest in any material.

Mr. FULTON. But not a program?

Admiral HAYWARD. No, we have a material program totaling about $6 million worth, but for this we don't have a program specifically. I would point out that in making this decision, I think it was correct, we are still available to talk about any material proposals to study this, to look to see where we could use it.

Mr. Pearson says, the loudest objections have come from the carrier admirals.

That is standard routine for this column anyway. The objection hasn't come from them; it has come from me and on a technical basis.

Mr. FULTON. And not on a budgetary basis?

Admiral HAYWARD. No. If this had to be competitive, it would have to come a long way before I would put more money in what was my material side of fiscal year 1960, and some of the other material problems I have had prior to this. The Goodyear Co. has a contract with us for the Subroc missile. I would be very interested to see if it is called for in that missile.

I don't think it will be, because I don't think it is in a position to be spelled out for a system. But that doesn't say we don't have interest in it as a material.

Mr. FULTON. But the Navy is open minded on a research and development program on this particular Wagmight and if it is shown to be feasible in the future, you would certainly give it consideration, would you not?

Admiral HAYWARD. I would, Mr. Fulton. One of the biggest problems that always faces me, I have lots of people come in with a lot of ideas. They have ideas, but to go from ideas to put numbers on their ideas usually costs me many millions of dollars.

When a man comes in with an idea and he wants to put numbers on it, then we want to see exactly what we are trying to get out of the program. What are we trying to accomplish?

And I felt in this case that from a selectivity point of view, which we always have in the budgetary process, this would have dropped out. I wouldn't spend my money on it.

Mr. FULTON. That is all.

Mr. HECHLER. Mr. King, do you have any questions?

Mr. KING. No.

Mr. HECHLER. Mr. Moeller, do you have any questions?

Captain BRIGHT. Could I make an unclassified statement at this time?

Mr. HECHLER. Proceed, Captain Bright.

STATEMENT OF CAPT. COOPER B. BRIGHT, OFFICE, CHIEF OF NAVAL OPERATIONS

Captain BRIGHT. I was instructed when I came over here to advise the committee that I could answer any questions and give any information that they desired.

However, I would be speaking for myself and not the Navy, as Admiral Hayward would speak officially for the Navy. But I would like to point out that what I say will not be my opinion, it will be based on the very extensive study done in the Navy and by the Navy and not by the Goodyear Aircraft Co. I feel very strongly, and I have for over 2 years, that this program offers a real opportunity to increase our defense posture to utilize the ships that we have today in our Navy to greater advantage in increasing the offensive and defensive capabilities of our fleet.

I don't think I should say any more now until we get into the presentation, but I think I can satisfy the committee that due diligence has been exercised and the procedures that are legal and orderly have been followed and that their time will be well spent to hear the presentation.

Mr. FULTON. Could I have some comment from you on practicality? You have talked on policy. Now, the question comes of how practical such a research and development program is and whether it would have a substantial chance of having a breakthrough or a moderate increase in our capabilities?

Would you comment on that?

Captain BRIGHT. Mr. Fulton, I have an engineering background, graduating from Rutgers University, 1931. I have served two tours in research and development in the Navy. I am familiar with, I think, the word "feasibility," and all the connotation it carries.

I think we have carried this study much further than others that I have been in that were funded and it is to a point now where unless we make another definite step to test this vehicle, we can go no further in establishing, not its practicality, but its ability to be produced in numbers for use on all the ships of the Navy.

Mr. FULTON. Of course, we are talking about a collapsible aircraft and a low-level aircraft with certain flight characteristics. The question is as to the competition of this particular craft with what you already have, and, secondly, as to the gain that might be obtained through the compressibility. Would you comment on that? They don't compress engines, they don't compress a lot of your radar equipment; they don't compress a lot of components that are on this plane.

Would you then comment as to what gain there would be, as well as the other factor I spoke about?

Captain BRIGHT. The gain as our study shows, is primarily, in major part, the foldability, sir, not so much—the foldability that is apparent.

Mr. FULTON. Of the wings or body structure?

Captain BRIGHT. Both, sir, it is inherent in fabric construction. It is the foldability that is the big and major factor that is making this advantageous to use as a weapon with ships at sea.

We don't fold the equipment, but we provide for it to be packaged as the wings and fuselage fold down into its plastic base or package.

Mr. FULTON. What gain do you have on this particular Wagmight model over a folded-wing version? I might say, incidentally, I have been a carrier bridge officer myself in World War II.

I would wonder just how much gain you would have over that type that you already have.

Captain BRIGHT. A considerable gain, sir. I was the Air Operations Officer on the U.S.S. *Yorktown*, the Fighting Lady; maybe we met out there on the Pacific. I was out there for 34 months.

Mr. FULTON. I was on a jeep carrier. You were the department store type?

Captain BRIGHT. I was the hangar-deck officer. I am familiar with those operations and I would say it gives us a chance to get back to what you remembered, where we had a mission aircraft to divebomb, we had aircraft to fight, and we had aircraft to drop torpedoes. It would give us a chance to go back to a mission aircraft which would mean the minimum amount of equipment to be folded.

Mr. FULTON. All you are going to do is fold the tail up?

Captain BRIGHT. No, sir; we are going to, as you will see later on, we are going to fold a considerable part of the fuselage structure, tail and wings.

Mr. FULTON. Of course, the wings I have already said, you fold in another model, but all you do is shorten the tail up and wrap the canvas up and put it in the driver's seat.

Captain BRIGHT. Compared to the way that you and I worked in World War II, with folding wings back, you will see there is quite an advance in the volume you consume when you fold them the way Wagmight folds them as compared to the hinged wings that we had in World War II.

Mr. HECHLER. Admiral Hayward, do you have a comment?

Admiral HAYWARD. Only I have the responsibility to assign the operations requirement. I wouldn't sign an operation requirement for this, Mr. Chairman. I still adhere to my decision, Mr. Chairman, and I am very anxious that you see the presentation and I will be the loyal opposition, let me say.

Captain Bright and I have discussed this. He knows my feeling on it. This isn't the only, let me say, item that I have turned down when it came to going along this way. There are a lot of other good things.

The one thing that I have always to remember, there are going to be many good things that I don't have the funds to pursue in A.S.W. in missiles, in aircraft, in ships, its submarines, and this is way down the list as far as I am concerned. Under the general ground rules that I have right now, it wouldn't survive.

Mr. FULTON. And for the past 30 years that has been the case right straight through on funds, no matter what administration has controlled the Federal Government, is that not right?

Admiral HAYWARD. That is true; yes, sir.

Mr. HECHLER. Captain Bright?

Captain BRIGHT. Mr. Chairman, as we go through the Navy and plot our career, I guess it is like navigating a ship, you look out for the old lighthouse at night and point of land during the day.

Admiral Hayward has been that to me since I have known him, particularly during this tour. One reason I have been persistent in keeping on with Wagmight, when discouragement was my lot, was because I always felt that I had Admiral Hayward behind me 100 percent, both in his expressions of confidence to keep going, and I think when you see this presentation, you will find that I—I like him a lot personally, and professionally, I think he is a tremendous man and he doesn't make out my fitness report, Mr. Chairman.

Mr. HECHLER. We hope you will continue to avoid the rocks and shoals.

Mr. FULTON. Could I ask you this just in closing? When doctors disagree, the patient prays. What happens when you engineers disagree?

Admiral HAYWARD. Well, if we have the money, Mr. Fulton, we usually build two models.

Mr. HECHLER. Admiral Coates, do you have anything to add to this in open session?

STATEMENT OF REAR ADM. L. D. COATES, BUREAU OF AERONAUTICS, DEPARTMENT OF THE NAVY

Admiral COATES. Sir, I believe I am the spearhead of the opposition or was at the time. I conducted the evaluation in Bureau of Aeronautics. I was at that time Assistant Chief of the Bureau of Aeronautics for Research and Development. And I do have some comments to make on the proposal, but I think that they would be easier to understand if you would see the presentation first.

Mr. HECHLER. Would it be agreeable to the Navy witnesses here if we do this: I think it would make for a more orderly procedure to proceed in open session with testimony by the Goodyear representative after which we could go into executive session.

Admiral HAYWARD. Yes, sir.

Mr. FULTON. In that case, Mr. Chairman, I would like to have in public the evaluation of the Admiral, that he had spoken about. I think we need your comment when you were head of BuAER.

Admiral COATES. I was not head of it; I was Assistant Chief.

Mr. FULTON. You were in charge of the program. I think we should have your evaluation at that time. If you have any further comments, let us have them.

Admiral COATES. Yes, sir. Do you want that now?

Mr. FULTON. Yes, sir; before Goodyear.

Admiral COATES. No, sir; I can't quote from this letter in open session.

Mr. FULTON. What is your evaluation currently?

Admiral COATES. If I may just discuss this in an unclassified way, when this was presented to me, it was claimed to have certain advantages, one of which was foldability and another one was cheapness of construction.

Now, interesting as it might be to an engineer, we would certainly not want to put the taxpayers' money into a different way of doing something just to see if we could do it.

It must offer some clear advantage. With my experience in airplane design and from looking at modern airplanes, they are packed full of things that don't fold, engines and engine ducts, electronics, the ejection seat that the pilot sits in, his instrument panel, the cockpit enclosure, the landing gear, the controls, not only the wing and tail movable surface controls, but engine controls, controls for his armament. The whole airplane, fuselage and wing are jammed full of equipment, components, and plumbing.

It seemed obvious to me that even if the shell of the airframe, by itself, could be folded, that we could not hope to fold a modern airplane made of flexible fabric because of the unfoldable things in the airplane.

Now, as to the advantage, the supposed advantage in cheapness of construction, it was represented to us that because this fabric would be made on a loom designed especially for the design of the particular airplane, that once the looms were made and set up, it could duplicate a large number of pieces quite inexpensively.

I am willing to grant that, but we saw so many unknowns and so many difficulties in developing this new technique adequately for high performance airplanes, that we thought that the time and money consumed in the development would more than eat up any possible savings in a fairly large number of subsequent production aircraft.

Now, one more point on cheapness. There was a time when the airframe was all there was to the airplane and a major part of the cost. That time has long gone. The mere shell of an airplane now, not counting all of the equipments, the components that go into it, and the attachments for those things, which you must have regardless of the structural material, the just plain shell of the airframe is quite a small part of its cost.

So that even a major saving in just the shell or the skin of the airframe, as you might call it, would not be a substantial saving in the overall cost of the airplane.

Mr. FULTON. Is there increased vulnerability, because of this type structure to say antiaircraft guns——

Admiral COATES. No, sir; I don't think so. It is continuously inflated in flight and it would be easy to provide for an excess of air supply so that you could have a fair number of holes punched in it and the air supply would keep up with the loss through those holes.

I wouldn't expect any great difference in vulnerability. Certainly, I have never doubted the feasibility of building and flying such a machine. In fact, there is a contract for 10 inflataplanes. They have been built and flown. These were low performance airplanes, quite low performance, puddlejumpers, with an absolute minimum of equipment.

Their foldability was achieved.

Mr. FULTON. That is all.

Mr. HECHLER. Any further questions of the Navy witness?

Mr. ANFUSO. May I ask the Admiral a question? I am sorry I was not here earlier, Admiral. This is a collapsible plane, is that right?

Admiral COATES. Yes, sir.

Mr. ANFUSO. For one or more passengers?

Admiral COATES. It could be made into anything, in fact, the name, Wagmight, doesn't refer to a design of a particular airplane, but to a concept of construction.

Mr. ANFUSO. It could also be unmanned, is that right?

Admiral COATES. Yes, sir.

Mr. ANFUSO. For special missions?

Admiral COATES. Yes, sir. Of course, that means putting in more equipment. You would have to replace the man with control and guidance equipment.

Mr. ANFUSO. How long would it take you to put it together?

Admiral COATES. You mean from its stowed or collapsed form?

Mr. ANFUSO. Yes, from its stowed and collapsed position.

Admiral COATES. It was represented to us that it might be set up ready to fly in 30 minutes, but I was never quite clear in my mind just what kind of a machine would be set up to fly in 30 minutes. I can readily imagine that a simple machine could be set up to fly in less than that. I don't know what the record is on the Inflataplane.

The Goodyear representative here can tell you that, but I am sure it is less than 30 minutes.

Mr. ANFUSO. Is it a Goodyear project?

Admiral COATES. Yes, sir.

Mr. ANFUSO. The Government is not at all involved?

Admiral COATES. No, sir. The Government is involved in a contract for the Inflataplanes, which are not identified with the name, Wagmight, although they use a similar method of construction.

Mr. ANFUSO. Which one are you espousing?

Admiral COATES. I am not espousing either.

Mr. ANFUSO. Neither one?

Admiral COATES. That is right.

Mr. ANFUSO. Are you opposed to this Goodyear project?

Admiral COATES. Yes, sir.

Mr. ANFUSO. And why?

Admiral COATES. For the reasons I just stated, sir, that to me the supposed advantages are not realizable, neither the foldability nor the cheapness.

Mr. ANFUSO. Is this your personal opinion or is it the opinion of the Navy?

Admiral COATES. Both, sir.

Mr. ANFUSO. Thank you.

Mr. HECHLER. Captain Bright, did you care to add anything?

Captain BRIGHT. Admiral Coates said this was a Goodyear product and not the Navy's and I noticed in the newspapers when this broke out into the print, that they said that Goodyear had conducted a study and submitted it to the Navy for evaluation and I would like to set the record straight, that this is not the case.

The Navy did the study and I was the project officer and the people on this committee were naval officers, civil service people and engineering talent from the Goodyear Aircraft Co.

We asked them to come in on a voluntary basis as we needed them to be part of a Navy study group.

When we finished the study, they were not in any way paid for their efforts. They haven't been to date and the findings of the Navy study were that we should ask them for a cost estimate which they submitted to our group in the Chief of Naval Operations, and we submitted this to the Bureau of Aeronautics.

At no time did they submit any proposal nor have they to date. It has been through the group in the Office of the Chief of Naval

Operations who did this study and who had the proposals presented to the Bureau of Aeronautics and the corps will bring this out.

Mr. HECHLER. I think at this time we ought to proceed to hear the representative of Goodyear, so that we would not detain Admiral Hayward, Admiral Coates, and Captain Bright too long in executive session. They have work to do. They will make a presentation in executive session, of course, after the Goodyear presentation.

So if the representative from Goodyear will come forward, I will swear him. Raise your right hand.

Mr. Pipitone, you do solemly swear the testimony you will give before this committee in the matters now under consideration will be the truth, the whole truth, and nothing but the truth, so help you God?

Mr. PIPITONE. I do.

Mr. HECHLER. Could you give your full name and position for the record?

STATEMENT OF S. JOSEPH PIPITONE, MANAGER, AIRCRAFT ANALYSIS GROUP, GOODYEAR AIRCRAFT CO.

Mr. PIPITONE. S. Joseph Pipitone. I am a manager of the aircraft analysis and development group at Goodyear Aircraft.

Mr. HECHLER. Could you give us a brief estimate of the time of your presentation?

Mr. PIPITONE. I wasn't prepared to give a presentation here today, sir. I was going to answer any technical questions that the committee felt they would like answers to.

Mr. HECHLER. Do any members of the committee have questions? Mr. Anfuso?

Mr. ANFUSO. Mr. Pipitone, will you please describe for the committee how this thing works and what you think about it?

Mr. PIPITONE. Yes, I would be very happy to. It is a little difficult, of course, to do this without some drawings and what-not.

Mr. ANFUSO. Do you have any drawings with you?

Mr. PIPITONE. No.

Admiral HAYWARD. Here is a picture of an inflataplane.

Mr. PIPITONE. Yes.

Admiral HAYWARD. That has been built, actually.

Admiral COATES. Yes, sir, built and flown.

Mr. ANFUSO. What is this made of, Mr. Pipitone?

Mr. PIPITONE. It consists of a fabric structure which actually is a membrane, which is prestressed and it is made of an orthotropic type of material. That is, the strain in each of the directions is not the same as it would be in a metal structure.

What it does consist of is the fabric here [indicating] and the engines, the wing coming out here, and the fabric tail surfaces.

When the pressure is on, in the vehicle, the fabric is pretensioned. This is not unusual in a structure. For instance, reinforced concrete, you have heard of prestressed concrete, wherein concrete is weak in tension and, therefore, they prestress it in compression, so it can carry tension loads. This is just the reverse. This material is—I prefer not to call it a material, because really it isn't, it is a structural concept, and it is based on the fact that when it is pretensioned, it

then can carry compression load, just the reverse of a pretension concrete.

Mr. ANFUSO. What kind of fuel do you use?

Mr. PIPITONE. This is JP-4, it is a regular jet engine. The air is supplied from the compressors or the last stage of the jet engine. Of course, this air would then have to go through a heat exchanger to cool off because it is around 600 degrees.

Mr. ANFUSO. Has this plane been flown?

Mr. PIPITONE. No, this is purely in a conceptual stage, a very preliminary conceptual stage. The only airplane that has been flown of this type of structure is the one-place and two-place Inflataplanes, the one that you have in your mind.

Mr. ANFUSO. Has this been flown?

Mr. PIPITONE. That has been flown, yes, sir.

Mr. ANFUSO. This is not your product?

Mr. PIPITON. Yes, sir, it is our product.

Mr. ANFUSO. This is also a Goodyear product?

Mr. PIPITONE. Yes, sir.

Mr. FULTON. Where is the landing gear?

Mr. PIPITONE. On this, this was designed with the concept that it would be zero launched and that it would land in the water on its return flight, if it was a manned aircraft.

If it was an unmanned aircraft, then, of course, it is a one-way trip.

Mr. ANFUSO. Why do you—have you known about the Navy's opposition to it?

Mr. PIPITONE. Well, formally, sir, we have not known—most of our dealings have been with the CNO in the design of this aircraft. We were lending technical assistance purely. We were approached as to whether or not we could technically accomplish this type of mission with this structural concept. We did furnish the technical information and we thoroughly believe that it is feasible, we know that it is feasible and we feel that it is well within the present state of the art, for the speed range wherein this vehicle's mission was to be accomplished.

Mr. ANFUSO. And what is the speed range?

Mr. PIPITONE. We know that we can do this up to around 400 knots. That is, I would like to clarify that a little bit, in that we have been asked many times why did we select 400 knots? When we were approached on this, and, of course, the people who were making this study would like as great a speed as they could possibly get. This allows a greater probability of penetration, and so on. So we put the limit—we did not feel that we could take the next logical step at a speed in excess of 400 knots. This is primarily due to the fact that above these speeds, when you put in the limiting dive speed of an aircraft with this cruise speed, that you are just below the speed range or mach number, wherein you would get the compressibility effects of the air and the attendant aeroelastic problems.

Mr. ANFUSO. You said you were asked whether you could put up this kind of a plane. Who asked you?

Mr. PIPITONE. What was the question?

Mr. ANFUSO. You said that you were asked whether or not you could put up this kind of a plane.

Mr. PIPITONE. Yes. We were asked by the people at Chief of Naval Operations, Captain Bright's people.

Mr. ANFUSO. Have you testified, Captain Bright?

Captain BRIGHT. Yes, sir.

Mr. ANFUSO. What have you said, have you said it is feasible?

Captain BRIGHT. Yes, sir, our study showed it was technically feasible.

Mr. ANFUSO. All right.

Mr. FULTON. Could somebody give us an engineering estimate of the percentage of compressibility when you are doing the folding? What space do you save and how valuable is that and then relate this price to something in this particular usability range?

Mr. PIPITONE. First, to answer the question, Mr. Fulton, if I understand you correctly, you wanted to know what volume reduction there was by folding.

Mr. FULTON. And also the configuration on a carrier deck? What do you save there?

Mr. PIPITONE. Well, on the hangar deck or in the hangar deck, if you take the distance from the floor to the upper deck, with the clearance that is provided there, you can stack these in their folded shape in capsule form. This means that you could put them, then, on racks, which would then take the volume that is projected by the normal aircraft. We can put 20 of these in the space, say, of an A4D.

Mr. FULTON. On a flight deck?

Mr. PIPITONE. No, that would be in the hangar deck I am referring to.

Mr. FULTON. Yes. Now on the flight deck.

Mr. PIPITONE. On the flight deck in its flight configuration, that is its regular inflated shape, it will then take exactly the same shape as another airplane of the same dimensions. That is, there is no difference when it is in its flight configuration than a normal airplane.

Mr. FULTON. So once you get it up to the level of the flight deck there is no difference whatever from an ordinary conformation?

Mr. PIPITONE. When you inflate it, it is a normal size airplane; that is right.

Mr. FULTON. And it is then chiefly in the storage at the hangar deck level, it is not in an operational status nor in a repair status, but for storage that you save this amount?

Mr. PIPITONE. Precisely right, from a logistics and handling and that sort of point.

Mr. FULTON. On the handling of it, how do you handle it differently on the hangar deck from the ordinary type plane?

Mr. PIPITONE. Well, you could have this capsule, or the container which holds it, on a dolly of some type and you can roll it around without having the objections of the damage that usually is imposed on aircraft being handled on the hangar deck. That is wing tips get dented, they meet obstructions, one airplane hits another. I am sure from your experience on a carrier you know what I am talking about here.

Mr. FULTON. Has there been an estimate on the difference in vulnerability of this type conformation from the ordinary plane on, say, enemy fire? Have you made any estimates on that?

Mr. PIPITONE. We did fire shells, I must qualify that: We fired 30 caliber bullets into our present Inflataplane and I think this was in

the neighborhood of half a dozen bullets, when the pump, which is a very small compressor on the Inflataplane, was able to keep up with this fire. One very fine feature about this is that when it is pierced by shrapnel or a bullet, the hole is a ragged one, which means that the orifice coefficient is quite high. That is the resistance to airflow is quite high. Therefore, with the abundant supply of compressor air from a jet-type engine, we are quite certain that we can sustain quite a bit of damage. In fact, it is very possible that we could sustain the type of damage that a metal aircraft could.

Mr. FULTON. Admiral Hayward, you seem to have a comment.

Admiral HAYWARD. Yes, sir. I go right back: I do not want the committee to get the idea that there is not promise in the small Inflataplane. I mean we and the Chief of the Bureau of Aeronautics, discussing it with me, say that the technique of packaging and inflating may have attractive possibilities in connection with the small ship packing and using of this for airdrops. The Army was interested in this. This is where it is packaged and actually dropped to somebody in the field. You can blow that up and fly it. But that is a 9-pound-per-square-inch machine, good for about 80 miles an hour, something of that kind. It is useful in this field. The argument was that it is actually—the decision was that it is not in the 400-knot field and it did not make good technical sense nor program sense for me to spell out a system employing this. I mean Admiral Coates covered in detail as to why that decision was made and I think you put your finger on it, from the electronics, the jet engine, actual controls, things of this kind is what our problem has been on that.

Mr. FULTON. Thank you.

Mr. HECHLER. I will say for the benefit of the members of the committee that the Navy has an executive session presentation of this project which perhaps we ought to move toward. Do other members of the committee have questions they would like to ask in open session? If not, we will proceed in executive session.

(Whereupon, at 2:40 p.m., the committee proceeded in executive session.)

(The executive session is classified and will not appear here.)

REVIEW OF THE SPACE PROGRAM

MONDAY, FEBRUARY 15, 1960

House of Representatives,
Committee on Science and Astronautics.
Washington, D.C.

The committee met at 10 a.m., Hon. Overton Brooks (chairman) presiding.

The Chairman. The committee will come to order.

This morning we are privileged to have Rear Adm. W. F. Raborn, who this committee knows well because of his previous appearances, and Admiral Connolly, who is Assistant Chief of the Bureau of Weapons for the Pacific Missile Range, and we are happy to have both of you gentlemen this morning.

Admiral Raborn is Director of Special Projects, Department of the Navy. We are happy to have you, Admiral, and we will be glad to have your statement.

May I ask you that are going to testify to hold up your right hands. Do you solemnly swear that the testimony you give before this committee in matters now under consideration will be the truth, the whole truth, and nothing but the truth, so help you, God?

Admiral Raborn. I do.

Admiral Connolly. I do.

The Chairman. At 11:30 the committee will go into executive session because of the special report to be given to the committee at that time. I believe, though, we will have finished with these two gentlemen in open session by 11:30. Now, Admiral Raborn.

Admiral Raborn. Shall I proceed, Mr. Chairman?

The Chairman. If you will.

Admiral Raborn. With your permission, I would like to submit my statement for the record and I would like to give you a short verbal presentation on our program followed with a short movie which will give you documentary evidence of our progress since the last time I had the pleasure of appearing before your committee.

The Chairman. Fine. Just in the order in which you wish it, Admiral.

Admiral Raborn. Thank you, sir.

The Chairman. Can all members of the committee see all right?

Mr. Bass. Yes.

STATEMENT OF REAR ADM. W. F. RABORN, USN, DIRECTOR, SPECIAL PROJECTS, DEPARTMENT OF THE NAVY

Admiral Raborn. Mr. Chairman, as you will recall, the Navy and the Army were partners in an attempt to use a liquid fuel missile

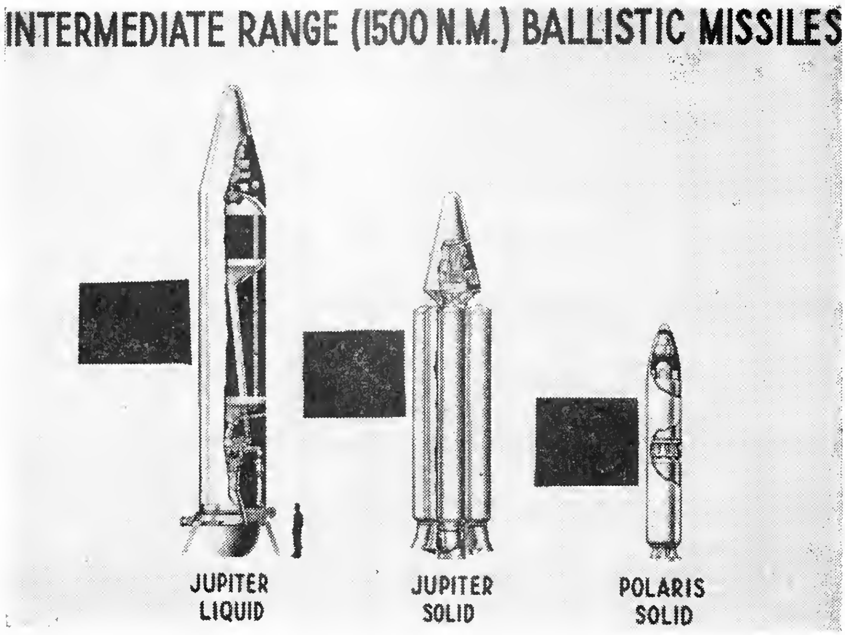

FIGURE 80

which was later named the Jupiter, shown here. After about 8 months of very profitable and happy association, it was determined that the use of liquid fuels aboard the confined spaces on the ships and particularly in submarines would make it infeasible from a point of view of safety (fig. 80).

So we tried to see if we could have a solid propellent missile which would utilize the nose cone and the guidance package of this missile. That is shown here (pointing to fig. 80). We did not build this, but because of its large weight, we found we could get very few aboard a surface vessel. About this time, of course, the AEC had a marked improvement in their warhead yield versus weight. We, in turn, in the Navy had a breakthrough in the amount of specific impulse or energy which we could get out of solid fuels. So it seems natural to tie the two together and we came up with what turned out to be the Polaris solid propellent missile, two-stage solid propellent missile, of marked decrease in size. This is the progression which we made (fig. 81, p. 620).

Next graph: Then the job as we were given it a couple or so years ago was to take the warhead, the solid propellant, develop the solid propellent motor and tie them together with a nuclear powered submarine which is represented by the *Nautilus* here (fig. 82, p. 620).

Essentially then it is to put a solid propellant ballistic missile in a nuclear powered submarine especially built for this purpose. The Navy, as you recall, sir, created a Manhattan district type organization which they called Special Projects.

This organization that it is my privilege to head reports directly to the Secretary of the Navy, and all departments and elements of

the Navy have been requested to support this program on a first-call basis, first priority basis.

The President of the United States has given the Polaris program coequal No. 1 priority to other programs in this category in the United States and being a Manhattan District type organization, our job is a total one. Build the missile, do the research development, production of the missile, build a nuclear-powered submarine, test the missile, provide the personnel, and provide this whole system operational to the fleet (fig. 83, p. 621).

As such, we are weapons systems managers and what we like to think of in the true sense of the word. Because if it has to be done and connected with the Polaris, it is our job. Doing this we have over 3,000 Government agencies and private contractors here which are engaged in this program (fig. 84, p. 621).

Shown on this view graph and I will read it because I know it is probably difficult from the front of the room. The partners which we have, Lockheed at Sunnyvale is the prime missile contractor and subcontracting to it for the motors is Aerojet General Corp. at Sacramento. General Electric at Pittsfield is doing the missile guidance under a subcontract to Lockheed (fig. 85, p. 622).

Lockheed is integrating and tying the whole missile system together, a very necessary job. The AEC, of course, is providing the warhead and the committee, joint committee on this, which is military and civilian, is chaired by a lieutenant commander in my shop.

I am very glad to say that this young fellow was chosen for this job because of his qualifications. He has a doctor of physics degree and is one of the brighter young men, I think, in uniform.

The shipboard navigation system is being done by Sperry, as well as the North American organization in California. There is a growing Government and industry team working on the FBM effort. I think this is a matter of interest that these dots show principal areas of work which are contributing to the fleet ballistic missile or Polaris weapons system (fig. 86, p. 623).

It covers the United States. I think this is significant because I am sure that coming from inland States such as I do, there is a prevalent feeling that when the Navy does work, that most of the benefit goes to States on the sea coast. This, of course, is not true. Next slide, please.

We have nine submarines under construction. Four of these are launched, one is commissioned, that is the *George Washington*, the one that is commissioned. We have three in the fiscal year 1961 program plus long lead time items for three additional submarines in the 1962 program (fig. 87, p. 623).

Next slide, please. The mode of operation is shown here on this view graph, sir, as you know we plan to eject the missile from the submarine underneath the water and start the first motor after it gets out of the water. This, of course, does away with danger inherent in igniting the missile inside of the submarine (fig. 88, p. 624).

It also gives us the stability of a submerged submarine. I was out on the *George Washington* not too long ago on her builder's trial and, Mr. Chairman, I want to tell you it is a beautiful ship. She is steady as a rock. I have been to sea 30 years, man and boy, and I spent a delightful night 300 feet below the surface of the Atlantic. It provides a very stable platform.

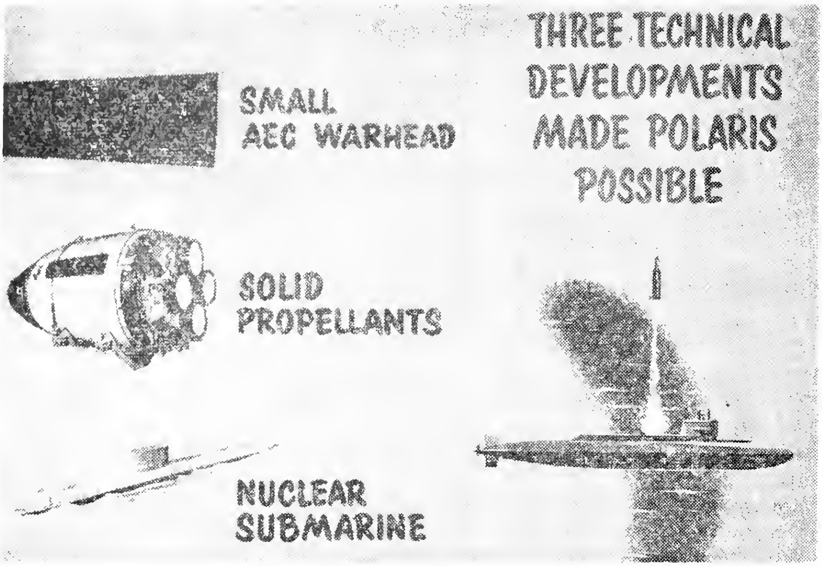

FIGURE 81

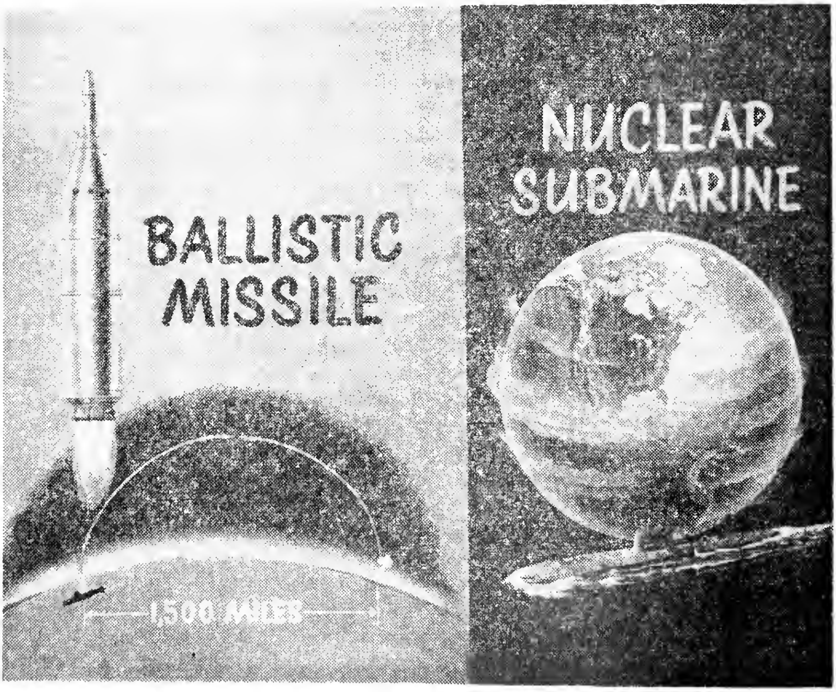

FIGURE 82

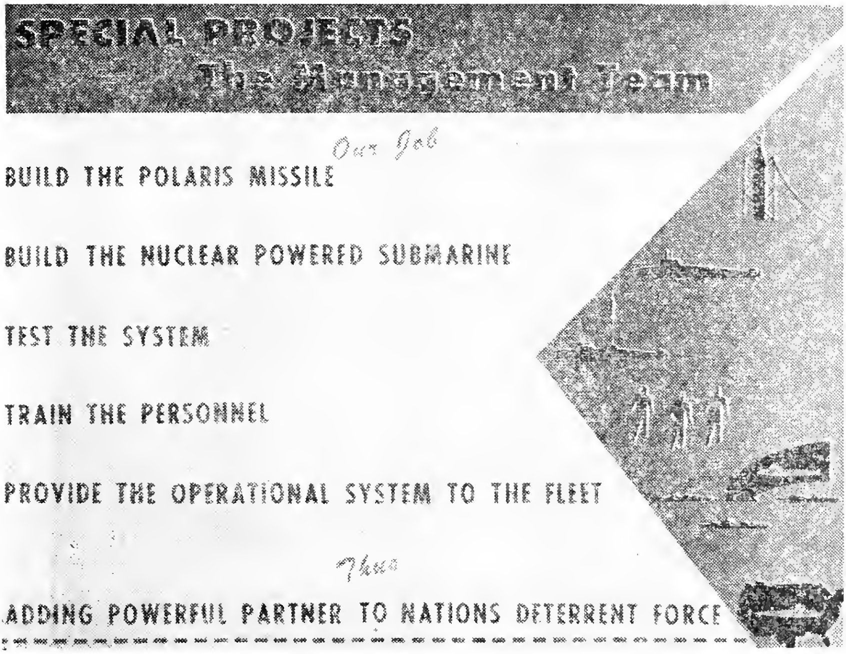

FIGURE 83

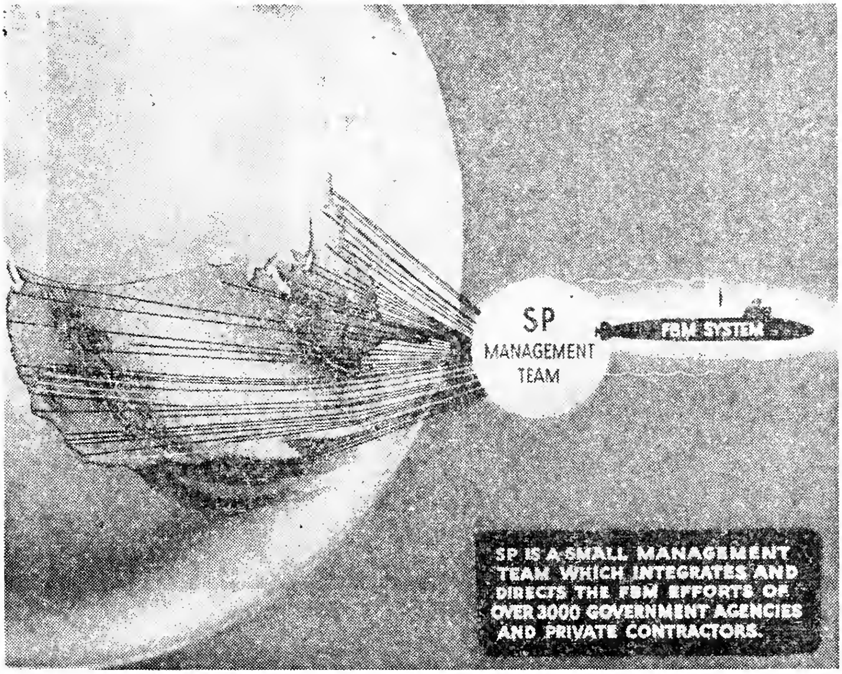

FIGURE 84

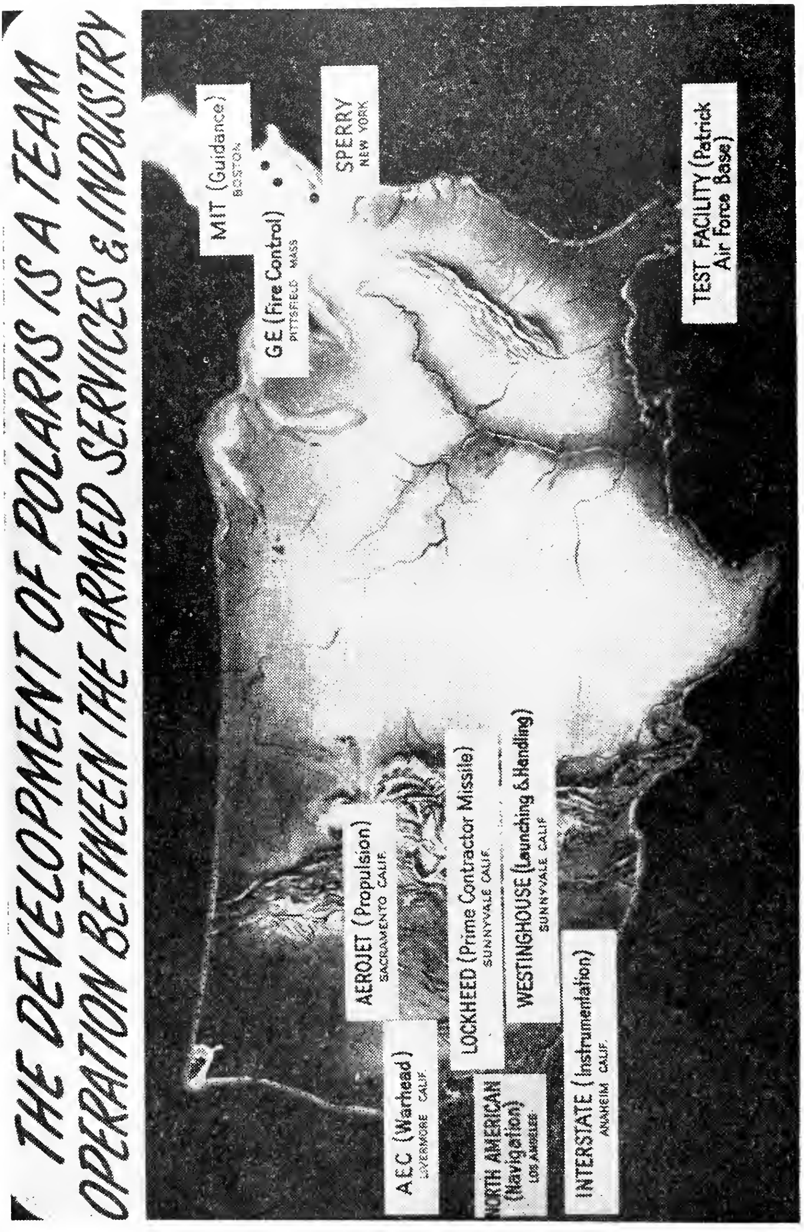
THE DEVELOPMENT OF POLARIS IS A TEAM
OPERATION BETWEEN THE ARMED SERVICES & INDUSTRY
MIT (Guidance)
BOSTON
GE (Fire Control)
PITTSFIELD MASS
SPERRY
NEW YORK
TEST FACILITY (Patrick
Air Force Base)
AEROJET (Propulsion)
SACRAMENTO CALIF.
LOCKHEED (Prime Contractor Missile)
SUNNYVALE CALIF.
WESTINGHOUSE (Launching & Handling)
SUNNYVALE CALIF.
INTERSTATE (Instrumentation)
ANAHEIM CALIF.
AEC (Warhead)
LIVERMORE CALIF.
ORTH AMERICAN
(Navigation)
LOS ANGELES

FIGURE 85

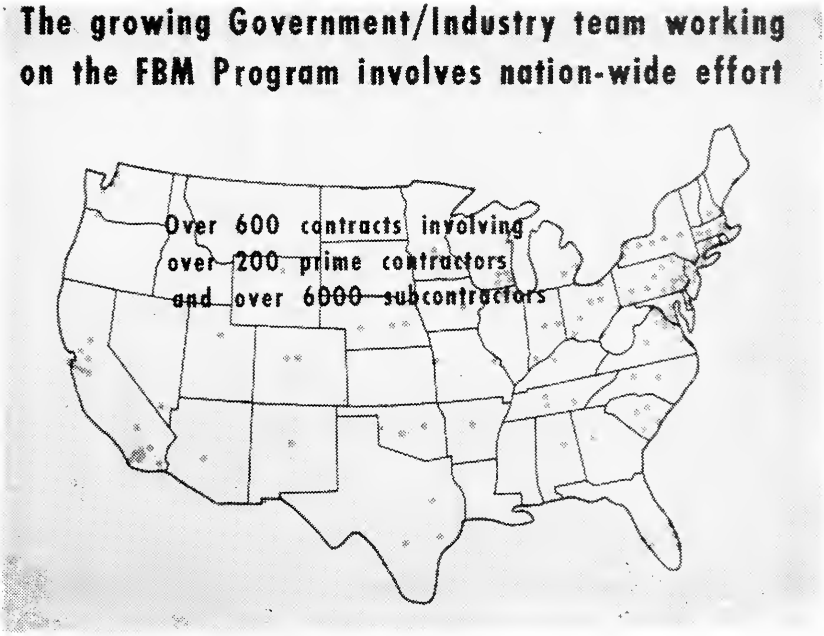

FIGURE 86

We fired a couple of slugs out of the launchers which was a service-like test of the launcher, itself, and the stability of the submarine during this operation was beautiful.

Mr. MILLER. Does it give you a good bang?

Admiral RABORN. No, sir. But the submarine is a large rascal and she is very stable. So we are very pleased with this. In fact, the *George Washington* has lived up to her specifications quite well.

FBM SUBMARINES

9 UNDER CONSTRUCTION

4 OF THESE LAUNCHED:

1 COMMISSIONED

3 IN FY 61 PROGRAM PLUS

PROCURE LONG LEAD TIME ITEMS
FOR 3 IN FY 62 PROGRAM

FIGURE 87

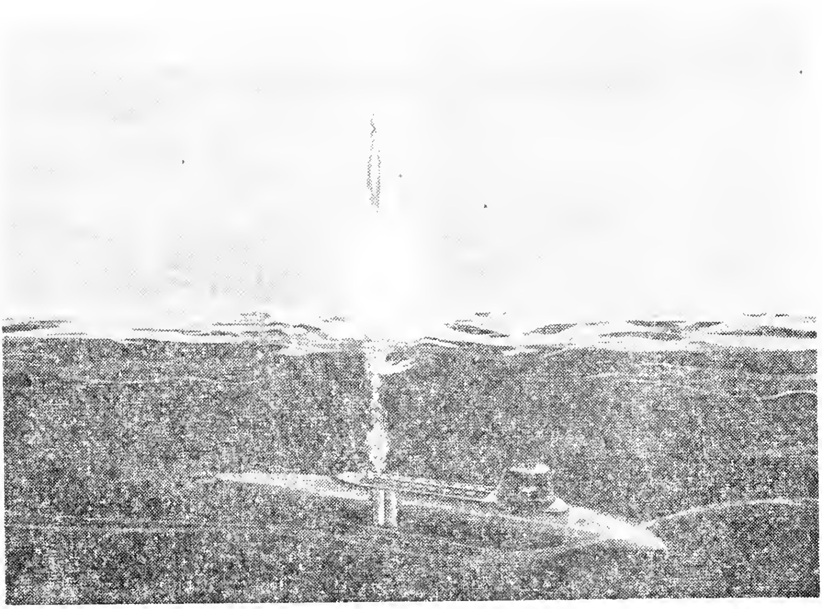

FIGURE 88

The crew, the spirit of the crew on her is tremendous. They are vastly motivated to do a good job (fig. 89).

This is a picture of the *George Washington.* It is a rather unusual one, as you see. The bow is actually to the left here and when she is steaming along, the water comes right on up—on the surface, the water comes right on up here. This is designed to go through the water instead of riding over it like a normal surface craft.

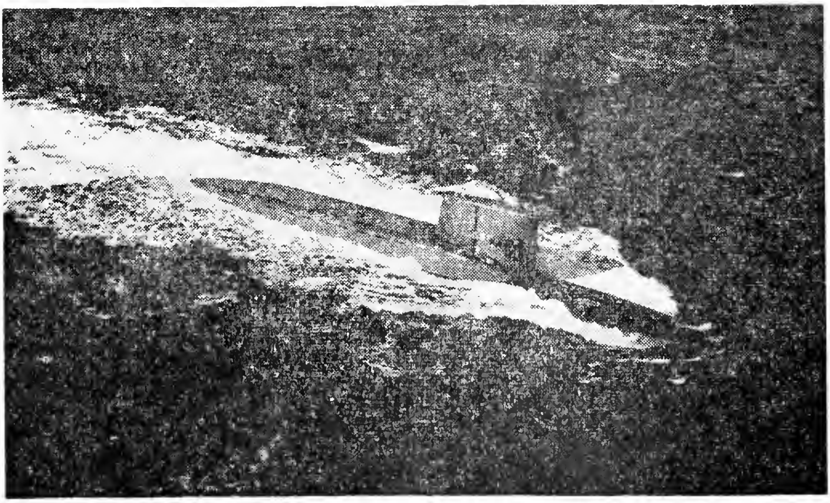

FIGURE 89

Of course, the missiles are housed back in here as you know, giving it that peculiar humpbacked design. Next slide. I would like to tell you a little bit about some of the major work areas which are conveniently labeled here because I think it is of importance that we remember that to bring a whole system like this into being that we have to talk about and do work in, human factors, communications, navigation, fire control, launching, propulsion, guidance, ballistic shell of the missile and, of course, the reentry body (fig. 90, p. 626).

This is a picture aboard one of our nuclear-powered submarines. Captain Jim Calvert who made the first trip underneath the pole. Of course, when we talk about human factors, we have to remember that with these complicated weapons systems, the man is the limiting factor when the machine has gotten past the capability of the man without due consideration as to how to operate them.

I mean by that, without engineering into the equipment a full recognition of the capabilities of the man who is to have to operate it. We have done this and Dr. Jack Dunlap of Dunlap & Associates, has been with me now as my top consultant for human engineering for a period of about 4 years and he has set up industrial engineering or human engineering elements in all of our major contractors and has seen that the equipments, as exotic as they may be, when brought into existence, that the man can use them and use them well.

We found some remarkable lapses from the consideration that the man had to use this and when we did the human engineering, why we made the equipments very acceptable.

Now, we don't stop at just engineering the equipment. We have to remember that when we shut ourselves off from the normal atmosphere of the earth for periods of months, that we are pioneering into many of the problems which space travelers will have to lick if they are going to do the job well.

Certainly, control of the air and the kind of air that we have in there is a major problem. Now, we have gone to great length aboard these ships to keep the air clean. We have scrubbers that take contaminants out of the air and we also have a very methodical far-reaching program to keep unwanted contaminants from getting into the air and to help me in this, I have two medical officers assigned to me by the Chief of Bureau of Medicine and Surgery. They have been with me 4 years now (fig. 91, p. 626).

One is a captain, Medical Corps, who is a long time submariner. The other one is a toxicologist of considerable competence.

Together, they are delving into the physiological as well as the psychological aspects of keeping crews alert and efficient over long time submergence and away from home.

In partnership with the National Institutes of Health and with work being done elsewhere, we have gone into this matter of keeping the air sweet and clean and to keep objectionable contaminants from getting into the air. For instance we have found that certain kinds of cooking oils release unacceptable contaminants to the air. It is necessary that we use another type; lubricating oils simply. Ridiculous as it may seem we have found that some types of aerosol, such as you have in shaving cream—you push a button and out comes a certain amount of shaving cream—we found some of the aerosols used in those cans release highly contaminating and objectionable

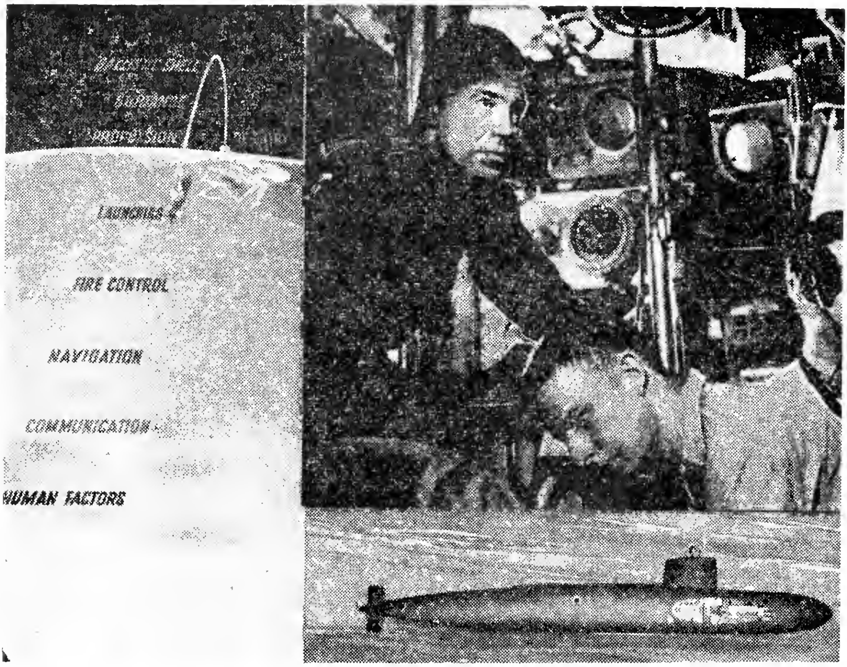

FIGURE 90

FIGURE 91

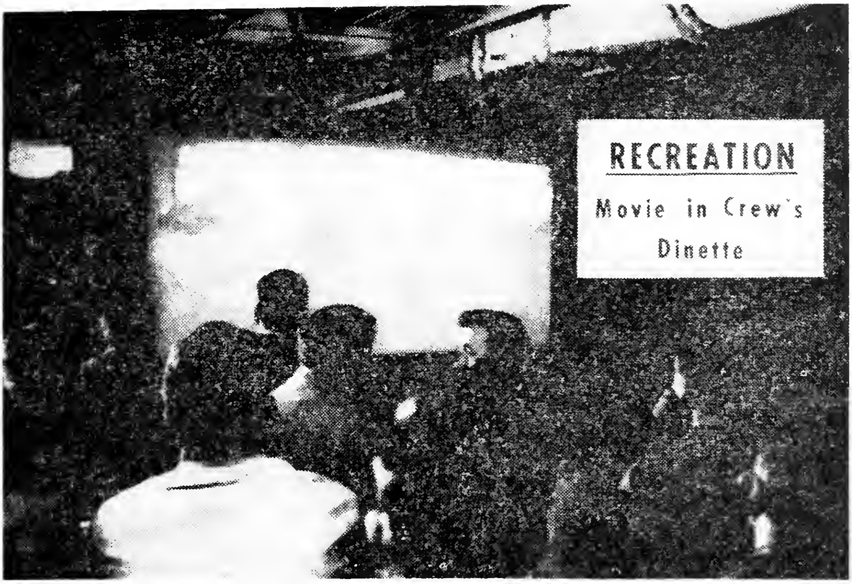

FIGURE 92

contaminants to the air. Therefore, we just shift the gas and get around this. This sounds ridiculous, but this is the kind of methodical approach to it that we are trying to take. Also, of course, we are looking into the recreation, well-being of the man to keep him happy. I am even trying to find a space for a two-man gym, so people can put on the gloves. Instead of carrying around a pout, they can get it out of their system (fig. 92).

Mr. FULTON. How about an old cigar stub?

Mr. MOELLER. I will put it down right now.

Admiral RABORN. I might say it is rather interesting that submariners—I have sharp pointed dolphins on myself—but submariners, almost invariably, smoke cigars. In fact, the 3 days I was on the *George Washington*, I came back puffing away on a cigar. Of course, they release objectionable contaminants to the air. I don't know what we are going to do about this, except we have these CO_2 scrubbers that clean the air out quite a bit. Perhaps we can have a smoking room.

Mr. FULTON. If you will give Congressman Moeller some dolphins, why that will make him acceptable here. [Laughter.]

Admiral RABORN. This is a picture of the crew mess aboard the *George Washington*. It is very large and quite spacious for a submarine. The food is good, as I can attest for the 3 days aboard and a couple of extra pounds, I believe. But all in all the comfort, the individual comfort of the man, we are looking after it with a great deal of attention. For instance, I have a whole bank of washing machines. A man has his laundry picked up by one of the crew and taken down and washed and nicely ironed and delivered to him. Of course, fresh water is not a critical factor aboard a nuclear powered submarine. You can have all the water you want, which is quite a thing (fig. 93, p. 628).

FIGURE 93

Mr. MILLER. How do the quarters here compare with those on the *Nautilus?*

Admiral RABORN. They are better. We have more space on this ship, it is a considerably larger ship. Our communications are coming along quite well. This is one of the things which we have concentrated on, and one of the responsibilities assigned to me is the effective communications with these ships. We are putting in a very powerful low frequency station shown here at Washington County, Maine, and, of course, this will parallel the other low frequency stations that we have in the State of Washington and in Hawaii and Annapolis and elsewhere.

By means of these communications stations as well as the high frequency stations, we can have these ships under constant communications reception throughout the world. I am very glad to say that we were able to improve considerably on the World War II technique, developed during World War II, of sending a message to a submerged submarine. So there isn't any question in our mind that we will be able to communicate with these submarines on a very effective and acceptable basis (fig. 94).

Mr. MILLER. You couldn't lend that to the Argentines right now, could you?

Admiral RABORN. Yes, sir; they are communicating the hard way there, with depth charges.

Navigation, of course, is another one of our major developmental areas and for this purpose we have had in commission over 3 years a navigational test ship which we converted. It is a converted Mariner; we got it from the Maritime Commission. We have in this all of the equipments which we have aboard *George Washington* as well

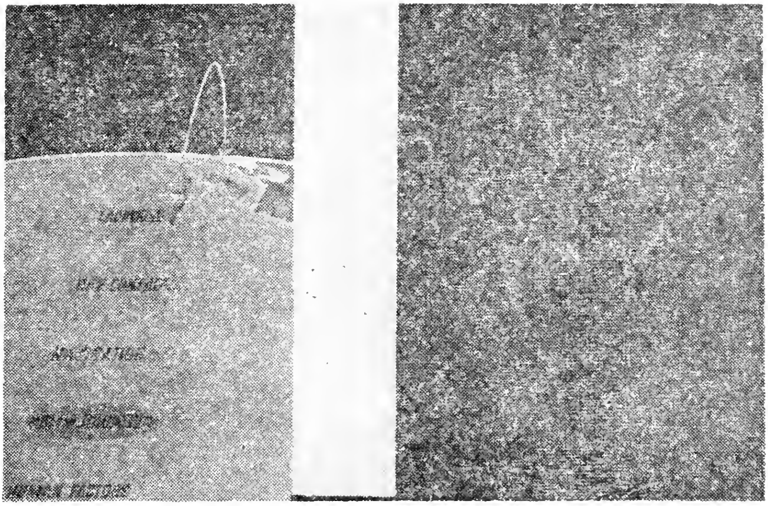

FIGURE 94

as some new ones coming along. For a period of 3 years we have been working out our problems of navigating effectively under actual conditions at sea. I can say to you, sir, without any quibbling at all that we have this problem very well in hand for our first submarines. The remarkable capabilities which we have coming along within the last 3 years has surprised all of us (fig. 95, p. 630).

Fire control, of course, is that part of the equipment in the weapons system which takes the shipborne navigation information, the position of the ship and the position of the target and ties them together in usable information for insertion into the missile guidance system. This equipment, we have some—a couple of dozen of these delivered already in various locations—actually operating the missiles where we are firing them, and they have proven out to be quite good. We are very happy with this. This is a beautiful piece of equipment and it involves some new techniques which the Navy did not know about before we started (fig. 96, p. 631).

The underwater launching has been one of our more spectacular development programs and it has come along to the point where this is no longer a problem. The success which the Navy has demonstrated in being able to launch large solid propellent ballistic missiles from below the ocean and into the air is quite marked (fig. 97, p. 631).

I am delighted, simply delighted, with this development and we have no problems here at all. We have full scale underwater test devices off of the San Clemente Island on the West Coast and there we are using the same equipment which is in the *George Washington*. We have been able to prove out under very highly controlled conditions and get really good information, scientific data. We have this equipment, of course, aboard the missile firing test ship, *Observation Island*, which has complete weapons systems equipment aboard, a duplicate of the equipment which the *George Washington* has. It has a couple of launchers aboard her and it is at Cape Canaveral now where she has already fired one very successful shot, ejecting

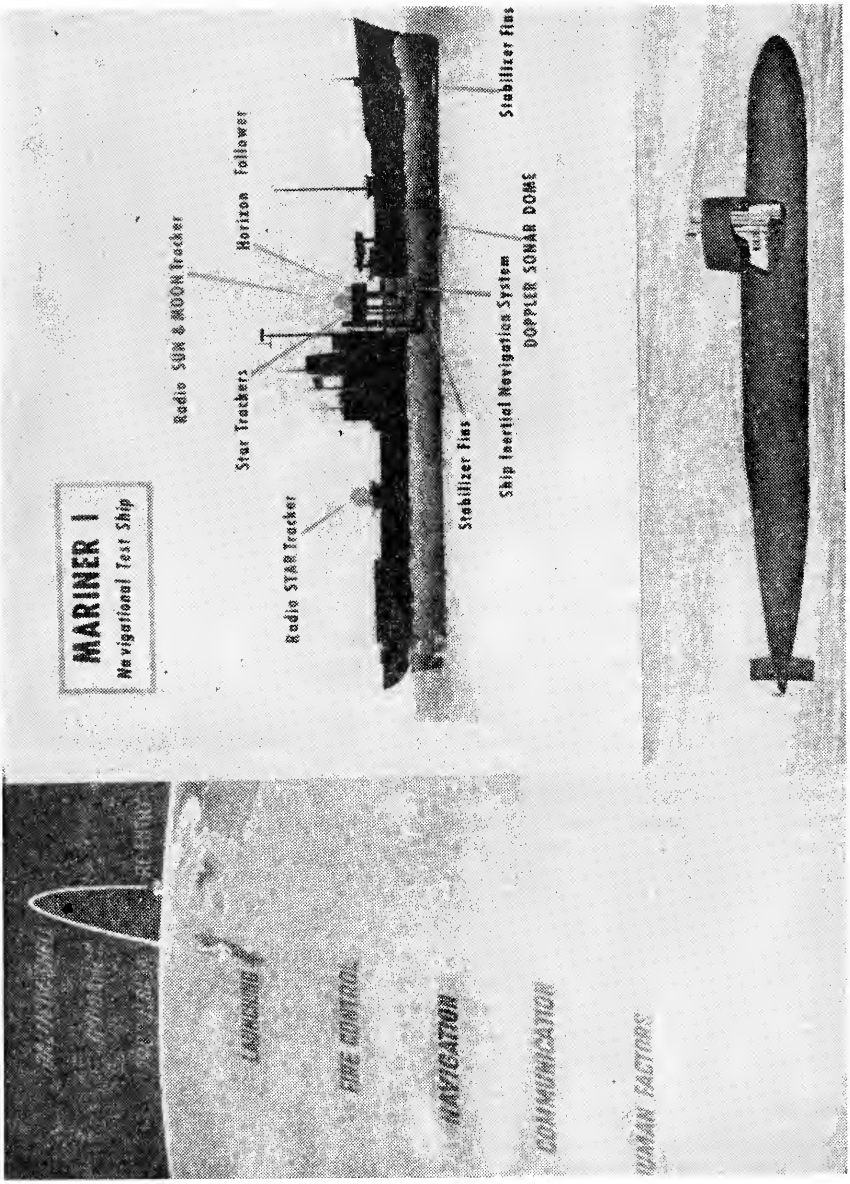
MARINER I
Navigational Test Ship
Radio SUN & MOON Tracker
Horizon Follower
Star Trackers
Radio STAR Tracker
Stabilizer Fins
Ship Inertial Navigation System
DOPPLER SONAR DOME
Stabilizer Fins
FIRE CONTROL
NAVIGATION
COMMUNICATION

FIGURE 95

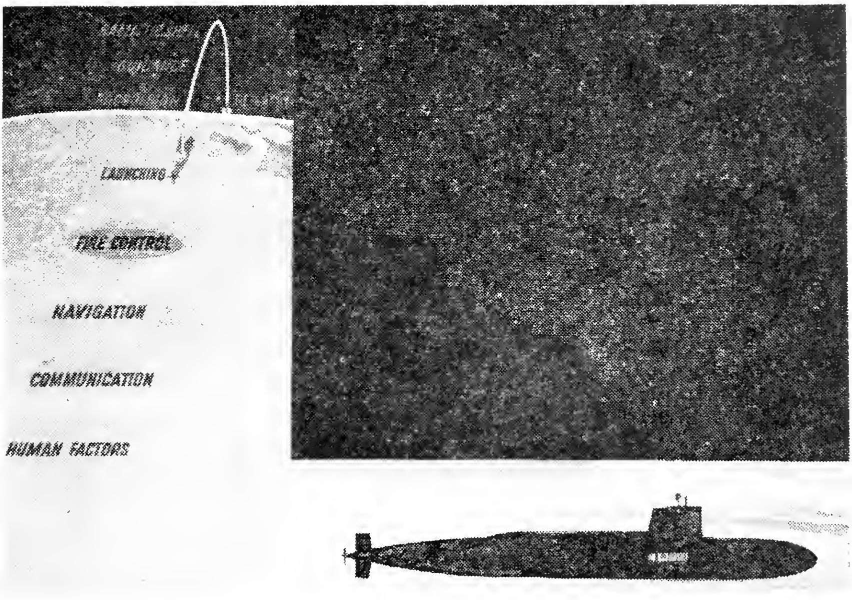

FIGURE 96

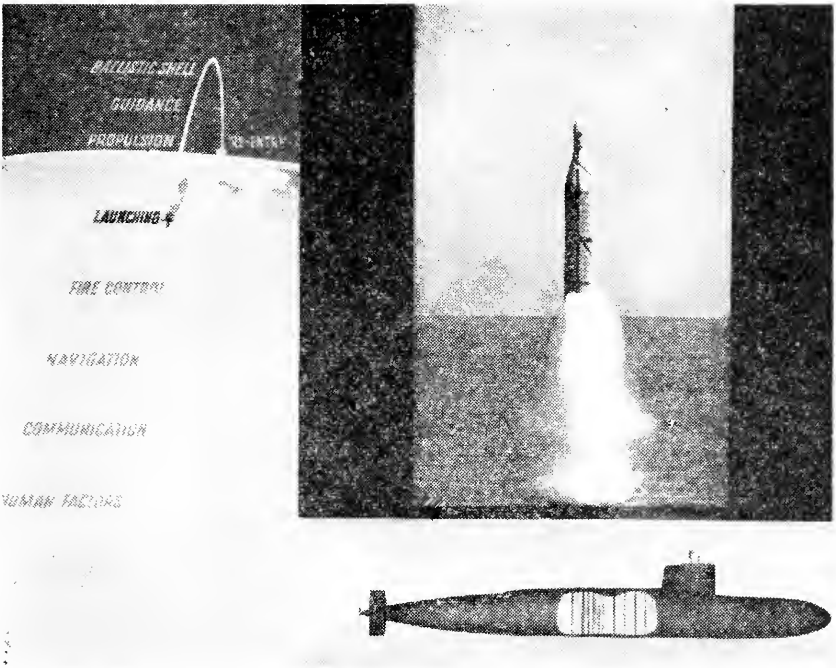

FIGURE 97

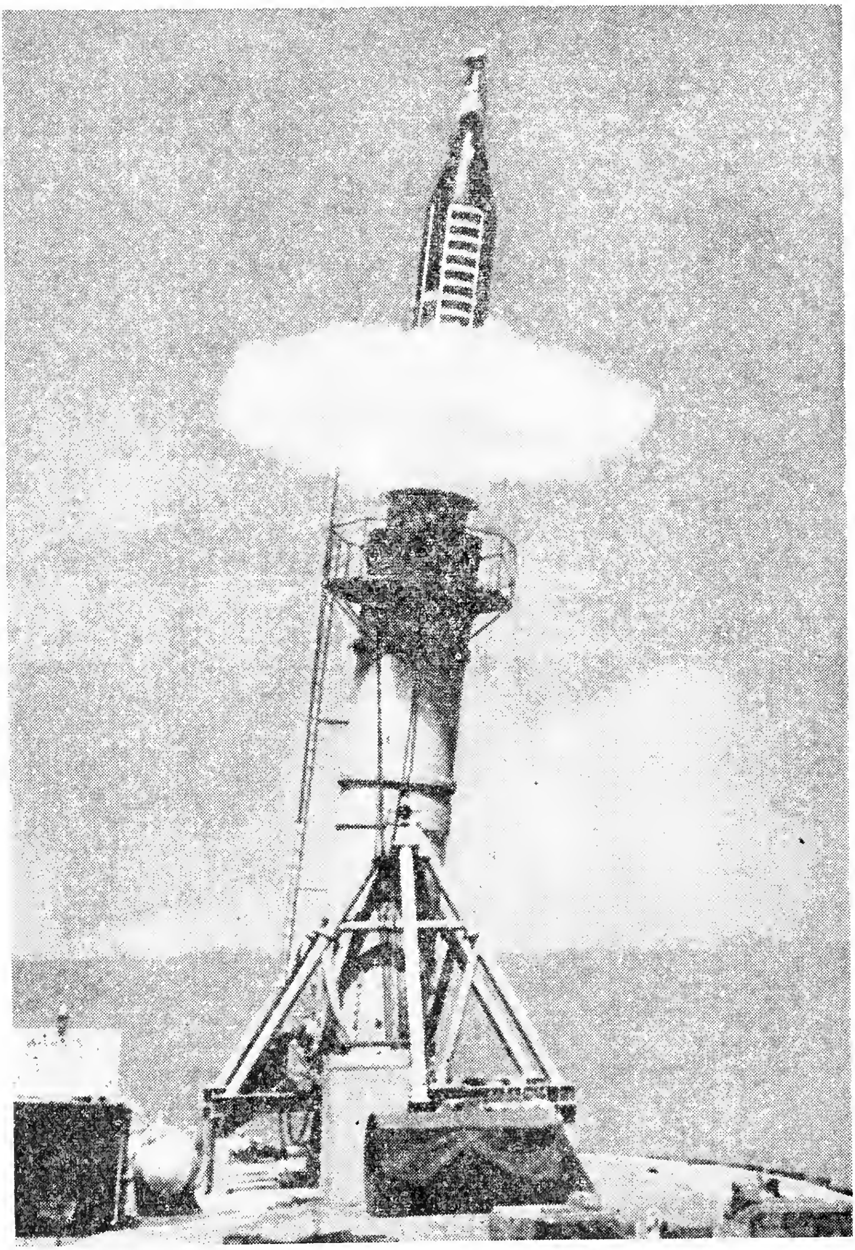

FIGURE 98

the missile into the air and off down range at wind. This shows one of our above-water launchers. This is at the Naval Shipyard in San Francisco. We get a great deal of data from this kind of a launcher. Of course, we have it below-water, as I mentioned before (fig. 98).

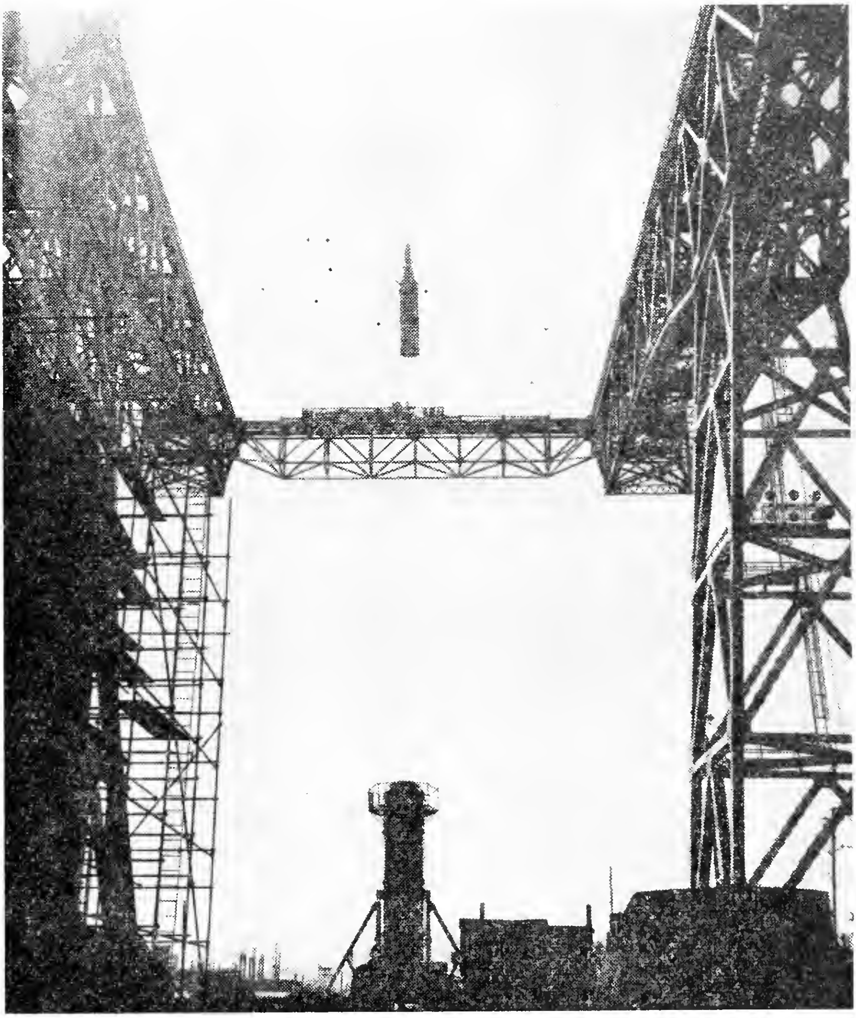

FIGURE 99

This is a cute gadget trick with which we save a great deal of dough every time we shoot one of these light-weight flight test type missiles. This building was already there. So we borrowed a spare aircraft arresting gear, put it on top of this crane and led a couple of wires down to this muscle of the above-water launcher and we fired this light-weight flight test vehicle into the air, which if we allowed to come to rest in the water would destroy itself and the expensive instruments in it. We catch it, however, in full flight up here and save about $1 million a shot. In fact, my boys save so much money here that they want to keep shooting long after—sort of false economy (fig. 99).

This is a seagoing version of the same thing. These are two steel barges, tied together catamaran fashion and this steel structure which

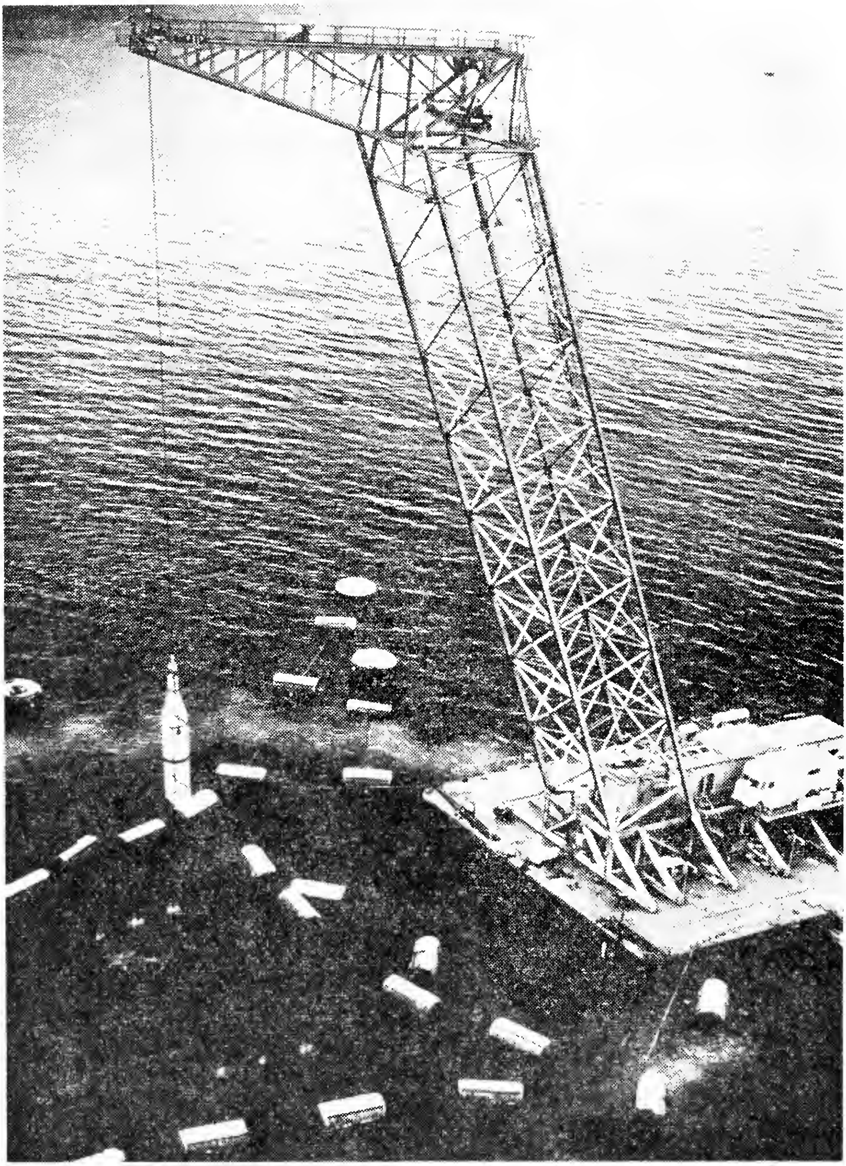

FIGURE 100

is erected on this, is about 200 feet from the top of this crane to the water. This is above the underwater launcher which is below those buoys. The missile is fired into the air and we have two engines in here, one takes the cable slack out without bothering the flight of the bird and the other catches it as it comes back. We prove it out full scale at sea (fig. 100).

Our oversized cocktail shaker or ship motion simulator has fired a couple of shots since the last time I appeared before this committee

Ship Motion Simulator

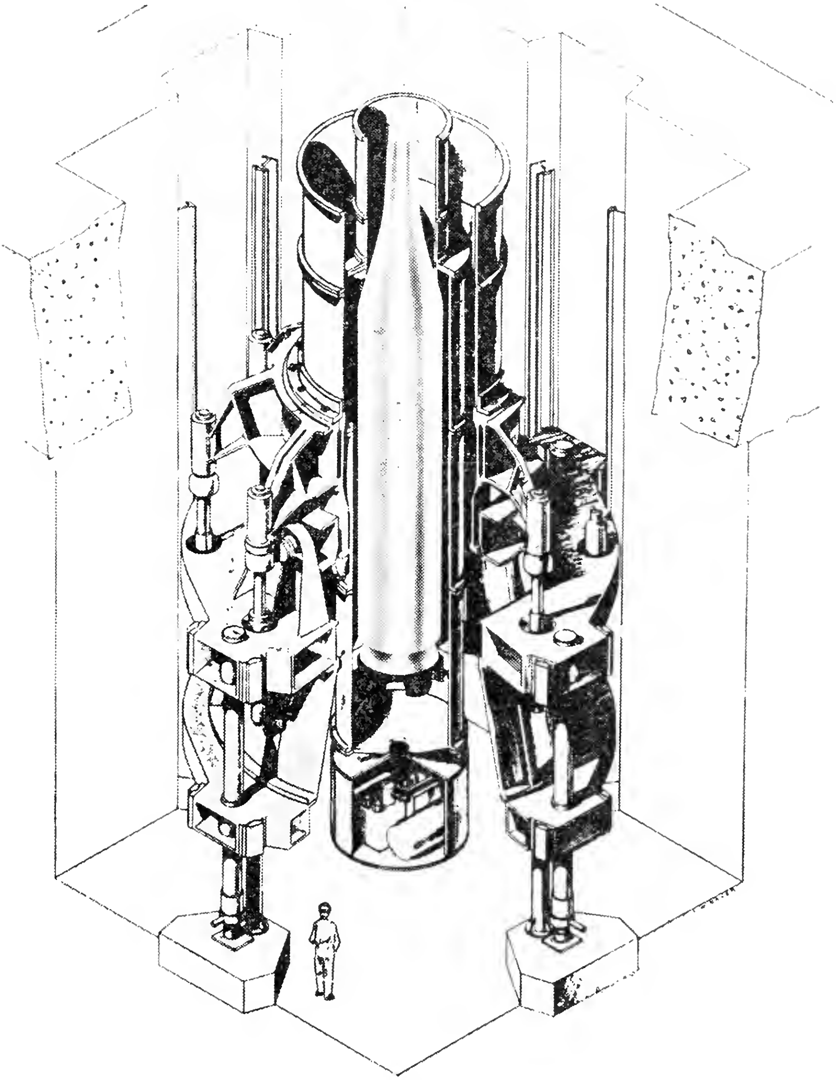

FIGURE 101

and very successfully. This is a full-scale launch of a live missile, we eject it, ignite it, and it goes off down range (fig. 101).

The next item in our development program we might talk about is propulsion. Propulsion, of course, is the development program of solid propellent motors. We have had our ups and downs in this as you would expect when you pioneer in large solid propellent missiles and were at our wits end sometimes to solve some of the problems, but we have solved them and solved them consistently and on schedule. We have a very usable solid propellent motor for this missile today.

Of course, we will improve it as we go along. It is quite safe. The Interstate Commerce Commission has granted us permission to ship this as a fire hazard and not as an explosive hazard. As a matter of fact we dropped one from 28,000 feet in an unprogramed test. [Laughter.]

And it deflagrated, it didn't detonate. A fellow asked me the other day the difference between the two, I said detonation is explosive enough to blow your pants off, but the other will leave your pants on. That was the only difference I could see (fig. 102).

The missile guidance system has done quite well. We are very proud of the way that the four full-scale flight tests which we have made since the last time I appeared before this committee have proven themselves out, with remarkable accuracy, as a matter of fact, far exceeded our expectations.

So we have this development area well in hand (fig. 103).

Ballistic shell, strangely enough is dictated primarily by the fact that it goes through the water on its way to being ignited and down toward its target. The strength of that was well proven out by an unprogramed outside loop in which we lost a jetevator on one of these first stages here and when they got up here and hit a strong cross-wind it couldn't correct it, so it did an outside loop, came around and went on down range very nicely. As I say, we don't normally loop the loop, when we program it, at least (fig. 104, p. 638).

The reentry body development is in good hands. We have proven it out, the ability of this reentry body to take the heat instant to the ranges involved, it is quite satisfactory (fig. 105, p. 638).

Our record of flight test vehicles shown here can be increased by one which was last week, it was a very successful shot. We have had 51 flight test vehicles of all kinds from little fellows to built-up ones into full-scale Polaris type missiles. Thirty-five of those have been quite successful in which all of our primary objectives were achieved. Fourteen of these have been partially successful in which one or more of our primary objectives were achieved and two of those have been unsuccessful by definition although we did learn as much on the unsuccessful ones as we did on the others, as far as the development program goes (fig. 106, p. 639).

We have had remarkably good success with the latest models or batch of test vehicles; 9 out of 12 have been successful, 3 of those are partially successful, and the last 6 flights have been fully successful. We are quite proud of that. I know how a certain football coach at Oklahoma must have felt after he had 40 straight wins. We don't know how long at this stage of the game we can keep having fully successful shots (fig. 107, p. 640).

The results of our flight test milestones to date—I will read them—in December of 1956 we fired our first flight test vehicle on schedule; we shot our first proof shot of our testing-out of the principles of the launcher in July 1957; our first underwater launch was done here in March 1958; we had our first full-scale flight test vehicle of the Polaris configuration fired in September on schedule and our first live shot from the ship motion simulator at Cape Canaveral was fired successfully, as well as from the *Observation Island*, sea test, on schedule. Our first guided flight from land was done January 7 of this year and from a schedule which we set up about 2 years ago it

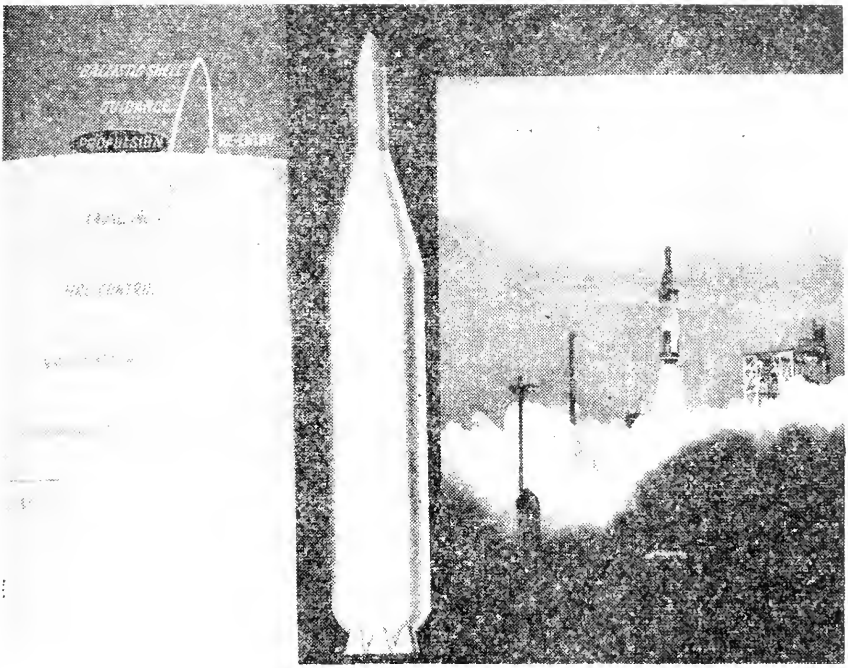

FIGURE 102

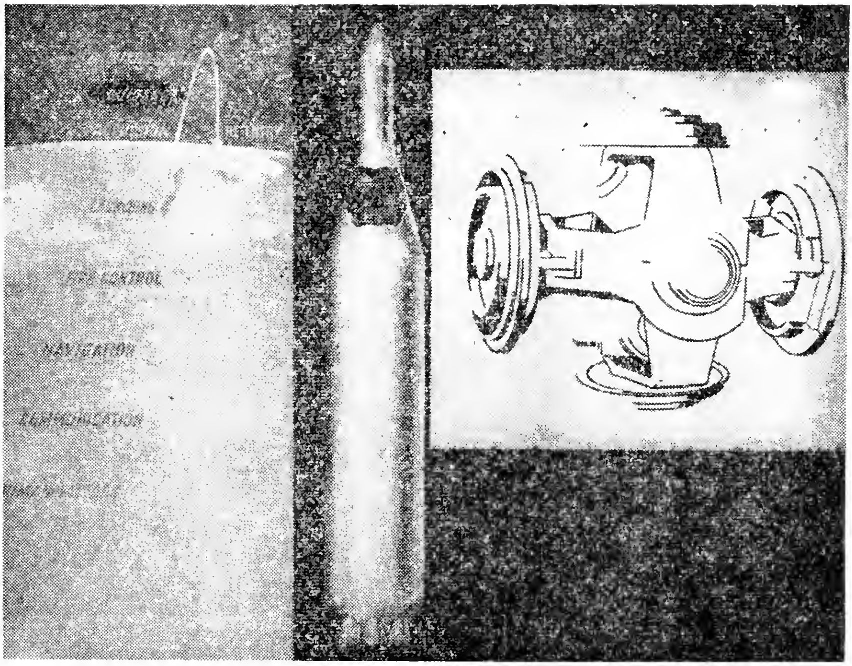

FIGURE 103

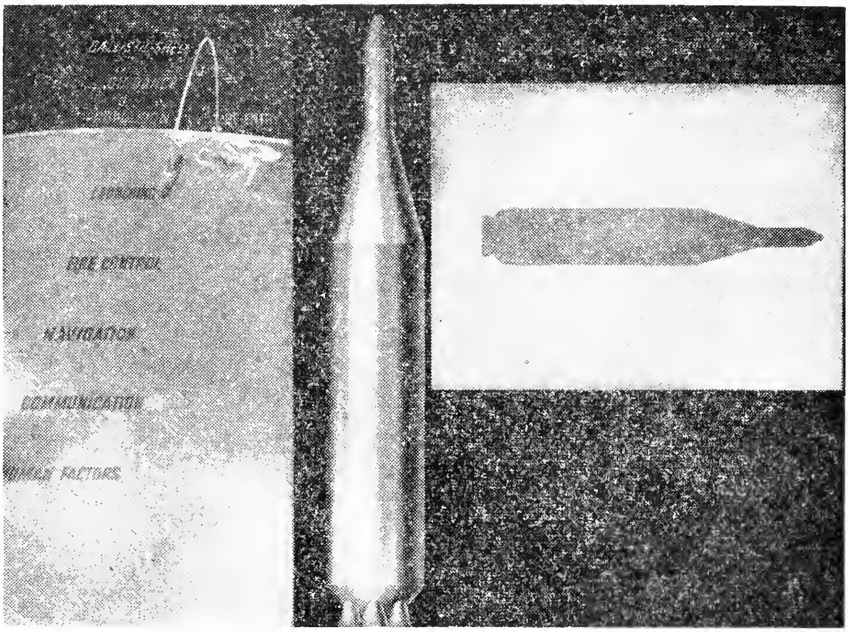

FIGURE 104

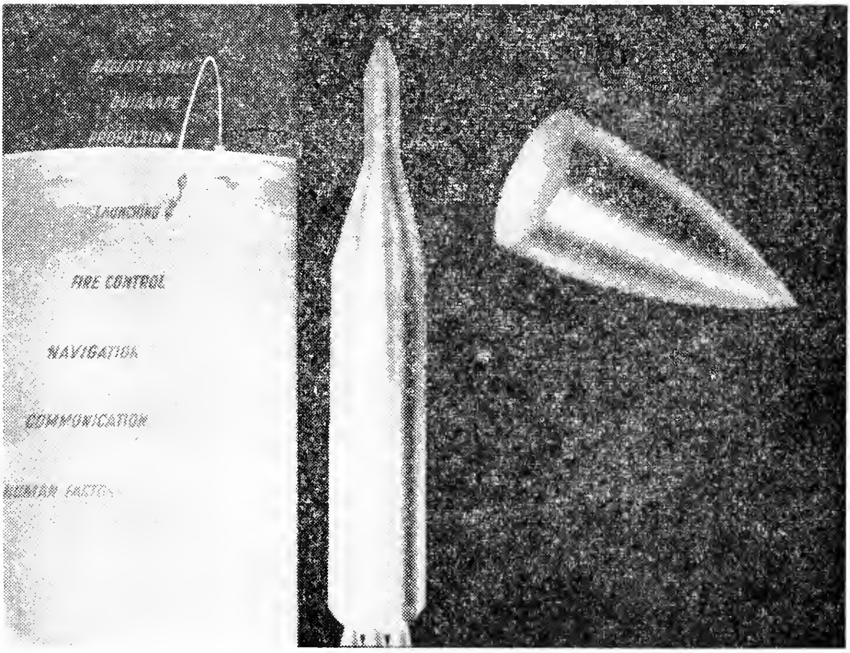

FIGURE 105

POLARIS COMPONENT DEVELOPMENT FLIGHT TEST RESULTS

35	DEMONSTRATED THRUST TERMINATION STAGE AND RE-ENTRY BODY SEPARATIONS FLIGHT CONTROL GUIDANCE COMPONENTS AND SYSTEM OPERATION SUITABLE PROPELLANT
14	PARTIALLY SUCCESSFUL
2	UNSUCCESSFUL

FIGURE 106

RESULTS OF THE POLARIS FLIGHT VEHICLE TESTS (A1X)

CONDUCTED FROM

SEPTEMBER 1959 THROUGH FEBRUARY 15, 1960

- 9 OUT OF 12 FULLY SUCCESSFUL
- 3 OUT OF 12 PARTIALLY SUCCESSFUL
- 6 OUT OF 6 FLIGHTS THIS YEAR FULLY SUCCESSFUL

FIGURE 107

was 1 week late, which I think is quite a high compliment to this developmental team that they can schedule something and meet it within a week. We have a couple of shots coming up which are rather significant, that is from the *Observation Island*, a fully guided test of all the equipment in the ship. This is a very significant test and, of course, we have an ignition from an underwater pop-up launch which will hold the hands of those folks who talk about the wet match (fig. 108, p. 642).

I think, sir, that would conclude my presentation. I have a short movie but I would prefer to show you the classified version in executive session unless you would like to see the unclassified version which I have also available.

The CHAIRMAN. Well, as between the two, it will take about the same time to see either one.

Admiral RABORN. Yes, sir. One is about 15 minutes; the other is about 10 minutes.

The CHAIRMAN. We had better see the classified version then.

Admiral RABORN. I think it would be more interesting to you.

The CHAIRMAN. All right. If there is no objection that is what we will do.

Admiral RABORN. All right. That concludes my report on the status.

The CHAIRMAN. May we ask you a question or two, Admiral?

You have a Manhattan-type program which means that you were able to get everything you needed for your program when you needed it, including the manpower and technicians and scientists and all of that. And that has given you the opportunity of staying abreast of your schedule. In fact, you are ahead of your schedule, aren't you?

Admiral RABORN. Yes, sir. We have been able to knock 3 years off the first anticipated operational date.

The CHAIRMAN. Three years?

Admiral RABORN. Yes, sir.

The CHAIRMAN. Do you attribute that to the fact that you have got the Manhattan-type organization?

Admiral RABORN. In part, sir.

The CHAIRMAN. Or do you attribute that to the superiority of the technique and the personnel?

Admiral RABORN. We would like to be modest on the second part of that, sir, but it is a well-known fact the Navy has been in the technical business a long time and we have a large reservoir of highly trained officers and civilians. Also a great deal of credit must be given to this wonderful contractual family, both civilian and military and high state of motivation of this contractual team. I think they are the best in the country.

The CHAIRMAN. Then you are satisfied with the development phase of the Polaris missile?

Admiral RABORN. Yes, sir; we are very pleased with it.

The CHAIRMAN. Actually, in the long run you are going to be short of Polaris submarines rather than missiles, aren't you?

Admiral RABORN. We are keeping them phased.

The CHAIRMAN. You are keeping them phased pretty well together?

Admiral RABORN. Yes, sir.

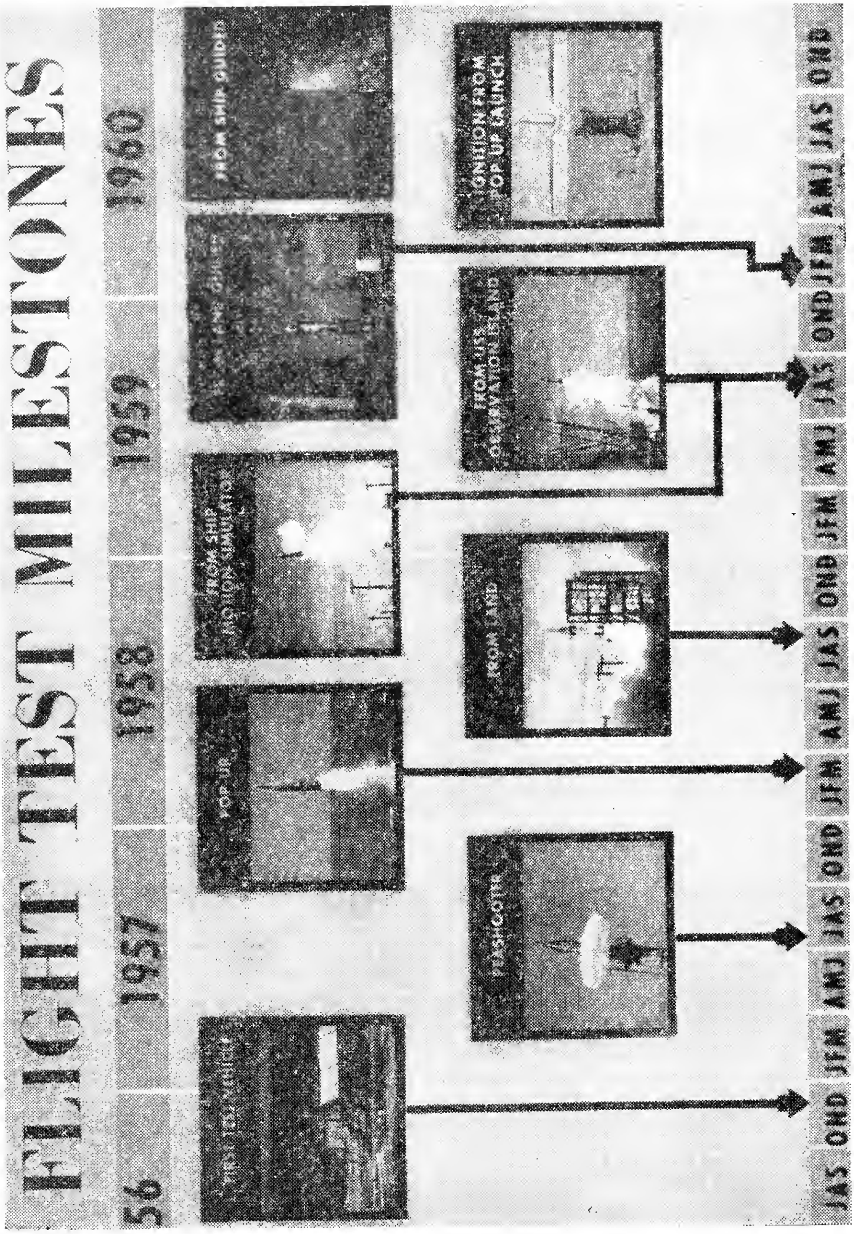
FLIGHT TEST MILESTONES
56
1957
1958
1959
1960
POP UP
FROM SHIP GUIDED
FROM LAND
JAS OND JFM AMJ JAS OND JFM AMJ JAS OND JFM AMJ JAS OND JFM AMJ JAS OND

FIGURE 108

The CHAIRMAN. So you will have more then. When will your Polaris become operational?

Admiral RABORN. We expect to have two operational by the end of this year.

The CHAIRMAN. From then on you build right on up?

Admiral RABORN. Yes, sir.

The CHAIRMAN. As your submarines become available so will your missiles?

Admiral RABORN. Yes, sir.

The CHAIRMAN. Mr. Fulton.

Mr. FULTON. Admiral, we are glad to have you here. That is a very interesting report. You, of course, know these weapons and capabilities as well as the boats. The question is then, how many of them should we in the United States have both as to time of construction and a target date for a force that would be a maneuverable force and would be, say, the equivalent in firepower, maybe of the Strategic Air Command?

Admiral RABORN. Mr. Fulton, I believe the Navy in general and I speak only from my own knowledge and not for the Navy, particularly, believes that this weapons system will be a most welcome and is a very necessary adjunct to the mix of weapons systems for major war deterrents. We certainly don't tout this as a panacea for all major war deterrents. We believe we should have an adequate number in inventory. That number will have to be determined by an overall look, by people in much higher positions than I and with broader responsibilities.

The Navy has thought that something in the order of 45 submarines at a building schedule which is dictated, of course, by those who have broader responsibilities, would be the proper number, about the proper number to have in inventory.

Mr. FULTON. Forty-five submarine Polaris fleet for all oceans within what kind of a building period? How long would it take to reach that?

Admiral RABORN. We can get up to a very large rate.

Mr. FULTON. What is your most economical rate?

Admiral RABORN. I think from the economy point of view it is about the same as a straightforward urgent building rate, about one a month.

Mr. FULTON. And how does that compare or correlate with the present proposed rate?

Admiral RABORN. We are building three a year now, sir, and, of course, we have all been told that they want us to prove ourselves out a little bit and this, of course, is what we are trying to do.

Mr. FULTON. Then would you say that decision as to the faster building rate should be made after you prove out your Polaris, say, on target areas with a certain CEP under actual submerged conditions? How much of a test period would you have as a research and development function before you came to make the decision to go ahead on a particular model or type Polaris and sub?

Admiral RABORN. I am a very bad person to ask that because my detailed knowledge of this program and the enthusiasm which we have——

Mr. FULTON. You are the very one we want to ask.

Admiral RABORN. Makes me—well, we all wonder——

Mr. FULTON. You are an optimist?

Admiral RABORN. Yes, sir; we are optimists, that is right. When you are in this field, if you are not it is kind of bad because you get discouraged mighty quickly. But in my humble opinion which, of course, will have to be passed on by those who have broader responsibilities, we have demonstrated the necessary technical assurance that those who have the decision, if they wish to go ahead and augment the program, they could do so with confidence. That is my opinion.

Mr. FULTON. At the present time?

Admiral RABORN. Yes, sir.

Mr. FULTON. On specific impulse would you compare your Polaris with both the Atlas and the Thor?

Admiral RABORN. Well—ours is considerably less than the liquid fuel rockets but is quite adequate for our purpose.

Mr. FULTON. On size and configuration would you compare the two, say, in proportionate firepower—how big would yours be if you had it with the firepower of an Atlas or a Thor?

Admiral RABORN. Well, this, of course——

Mr. FULTON. Bigger or smaller?

Admiral RABORN. This gets into classified matters pretty fast, Mr. Fulton.

Mr. FULTON. When you compare yours—why shouldn't we make the Polaris bigger if it is capable of being handled so easily and can be stored, obviously, while these others take such a long countdown? Why don't we make yours bigger, larger and have it as a competitor of the Thor and the Atlas; or, for example, while we are thinking with imagination, cluster it and have it as a competitor of the Saturn? Is that possible? I am talking of your applications, where you might go from here. I mean when you pop up out of the water you might pop further than you think.

Admiral RABORN. Yes, sir. First let me give you a general answer as to the size. The size of the Polaris warhead is quite adequate to do the job and to increase the size of the Polaris warhead inordinately doesn't buy you a great deal. This is a very powerful warhead and one most adequate to do the job. This, of course, is all you need. You don't have to blow a squirrel's head off, for instance, to kill the squirrel, so to speak.

As for applications in other matters, clustering it and so forth. Solid propellant motors have been used for this in the past, in say, second or third stages of some of our space probes. As you know we have had clusters of solid propellant motors. I would think that those who have to do with space vehicles expertly are keeping abreast of what we are doing. Should they have a need for our type of clustered motor, Polaris type, they will certainly call on us.

Mr. FULTON. I am talking about a different thing. I am saying: What are the capabilities of Polaris technically for clustering purposes in competition, for example, with Atlas, Thor, Saturn, or Minuteman? I am saying where could you use this engine otherwise on other projects that are now very costly? Is there a possibility of such a development of the Polaris? I think people would be very interested.

Admiral Hayward, could you add to that?

Admiral HAYWARD. Well, I want to say, Mr. Fulton, I have the same confidence that Admiral Raborn has in Polaris. People question Polaris. I don't understand this for the simple reason that they seem to assume that Minuteman is here and as Polaris succeeds, Minuteman succeeds. It is tied to the same warhead technology, has a more difficult problem than we have. When you spoke about using this to replace liquid missiles, I am sure this is what Benny Schriever is doing with his Minuteman. I mean this is the solid. It is geared to the same progress that we are making in Polaris. I would comment on the number——

Mr. FULTON. So that really the Minuteman is a progression of your solid propellant through the developments that you people have already developed rather than on a liquid propellant basis?

Admiral HAYWARD. Yes, sir. The Minuteman is an outgrowth of the reaction time problem that you have with the liquids, but I feel personally, myself, from a technical point of view, that it is not an either/or situation between liquids and solids.

Liquids are storable, some of the real large warheads, quite large payloads that you want into space, it may be a liquid device. I don't think that it can be just said black or white, that you are going to go all solids. You are in about 240 pound seconds, that is the present Polaris, that is at a thousand pounds per square inch at sea level, because a lot of people quote specific impulse of 280 and 267, but this is at higher altitudes.

Roughly in the next 10 years I would say it will be up to about 257 or 260. I don't know whether Red [Admiral Raborn] agrees with this. It is roughly in that order of magnitude. So that the solid, where your present liquids are around 300 seconds, I don't think it is an either/or situation.

Mr. FULTON. My point was this, that we are doing so well on the configuration and warhead and with the solid fuel engine in the Polaris, why don't we extend the field beyond the Polaris?

Admiral HAYWARD. We are. If you mean a growth of the Polaris, certainly.

Mr. FULTON. Yes.

Admiral HAYWARD. Obviously as we go up, the range of this has gone up to 2,500 or gone on to some greater range. There is no question that this buys you a tremendous amount from the sea.

You have got 70 percent of the Earth's surface in it. So you can use and employ very effectively additional ranges and we certainly will have a follow on to the Polaris.

Mr. FULTON. So really you could get to an ICBM Polaris, couldn't you?

Admiral HAYWARD. Of course, the Navy's position is that the Polaris is an ICBM now. Our first stage is the *George Washington.* This is a very efficient first stage and we like it very much. It feeds much better than some of the other first stages, let's say. But it is an ICBM now.

Mr. FULTON. The ICBM flight range compared to your range in Polaris, there is a difference, but with the capability of the range of the *George Washington* added to an IRBM range, the Polaris, it is ICBM?

Admiral HAYWARD. Yes, sir.

Mr. FULTON. But I am talking about an ICBM flight range of the Polaris, why don't you push it up and make it an ICBM in its own right?

Admiral HAYWARD. In this year's budget we have $10 million in the research and development program just for looking at the followon to this system. The work that Admiral Raborn now is doing in specifications and warhead and all of it leads to just what you are saying.

Mr. FULTON. You need more money?

Admiral HAYWARD. I always need more money, Mr. Fulton.

Mr. FULTON. How much would you need to do that in the coming year? You see, we are interested in it.

Admiral HAYWARD. In the coming year?

Mr. FULTON. In the coming fiscal year.

Admiral HAYWARD. My feeling was that with this $10 million, if it survives all the way through, that we would be able in the 1962 budget to go forward with a pretty firm program. Now, we have to do this, of course, without interfering too much with Admiral Raborn's work right now. We don't want him to slow down on the Polaris, it is too important to the United States.

However, Admiral Raborn will have the management of this money, but we feel in 1962 we should be able to come in with a pretty good program for that.

Mr. FULTON. You would feel that $10 million is your optimum rate of expenditure?

Admiral HAYWARD. I believe so. I base this on the figures that Admiral Raborn submitted to us, really. His scientists took a good look at this program and he submitted this cost. Maybe he needs more, I don't know. He hasn't told me about it.

Mr. FULTON. This is, now, across party lines, we want you able, thoroughly, to do the job.

Admiral RABORN. I can expand on Admiral Hayward's remarks there and fill in a little bit. We, of course, are driving toward the 1,500-mile system. This, of course, will be an improvement over our first missile range. The 1,500-mile missile is an intermediate step toward whatever increase in range and performance that we would want to build into the Polaris missiles.

So we are, in effect, going pretty fast in that direction and if you look at the time scale of the Minuteman, you can see that the techniques which we are pioneering in solid propellant ballistic missiles give us a good step to make a marked improvement in the performance of the Polaris, about the same time that they expect to make theirs.

Of course, we are walking down the same path together as far as the second and third generation down the road.

Mr. FULTON. As a Navy man, I think it will probably be a submarine, first thought out by Hayward and probably produced by Admirals Raborn and/or Rickover, that will first circumnavigate the Moon from the United States.

The CHAIRMAN. Mr. McCormack.

Mr. MCCORMACK. I will pass.

The CHAIRMAN. Mr. Bass?

Mr. BASS. Mr. Chairman, I hope we can get to this movie. At the present rate we will never get through here. I would like very much to see this movie.

The CHAIRMAN. We are going into executive session at 11:30 for that purpose. Mr. Miller?

Mr. MILLER. I pass.

The CHAIRMAN. Mr. Hechler?

Mr. HECHLER. I think that everyone in this country can be justly and enthusiastically proud of the tremendous achievement of the Navy. Admiral Raborn, with respect to the Polaris development. Admiral Hayward, I would like to ask you this question very carefully so that it comes within your jurisdiction. I am impressed by the nature of the organization that has been developed in creating and producing Polaris. Now, the question I would like to ask you is whether your own personal job wouldn't be easier if this same type of organization with its attendant priority, leadership and other factors, mobilizing men and material, were, in effect, in the entire space and missile program that our country has?

Admiral HAYWARD. The difficulty is that it crosses some of the scientific, the physical sciences cross so many fields that you would be doing this for everything. Now, Polaris has a specific objective and a specific program. There are a lot of things that we do in the other programs that you would find that it would be burdened down with so many jobs that it wouldn't accomplish its purpose.

Now, I can name any number of missiles. If you did this just for all missiles, let's say, this would be a tremendous organization, a tremendous thing.

Mr. HECHLER. I was impressed by the testimony you gave a year ago before this committee which would seem to point toward that goal.

Admiral HAYWARD. When I testified, I testified on the national space exploration program and I still think a national space exploration program makes sense.

Mr. HECHLER. A single one?

Admiral HAYWARD. Yes, a national space exploration, you see. This is a specific program.

Mr. HECHLER. And you don't think we have that now?

Admiral HAYWARD. Well, under the present bill we don't. The proposed legislation for the first time talks about a national space exploration program. There are not going to be many trips to Venus or the Moon or things like that, so you are going to have to have one program set up like Polaris for it.

Mr. HECHLER. Admiral Raborn, I would like to ask you if you could relate some of the lead time involved in Polaris development with comparable development of other missiles?

In other words, do you feel that we can get this job done much faster, were more emphasis put on the Polaris program?

Admiral RABORN. I think principally it is dependent upon the lead time of long lead components. For instance, the reactors for our nuclear-powered submarines which are the same which we use in our killer submarines—they use the same type of engines and so forth—there is about a 46-month lead time to buy, manufacture, install and check out the nuclear engine room.

Mr. HECHLER. What I am trying to do is open up for you an opportunity to demonstrate why we should put more emphasis on Polaris in our national defense. As I understand, you have been able to get about 3 years ahead of your schedule in making Polaris operational. Now, can you add anything further that would cause us, as a Nation,

to want to emphasize this program to a greater extent than programs that are going on in other areas?

Admiral HAYWARD. I would answer that, Mr. Hechler. For instance, that is a really good subject, long lead time. If you had had the faith in Admiral Raborn in 1956 when we came and presented this program and you had gone forth with our program then, today you would begin—this particular year you would begin producing these submarines at the rate of one a month, and there would be no argument by anybody then that you didn't have the power or that there was any so-called gap, whether it is missile or deterrent or anything, because they would be coming off the line.

Those are the hard decisions that have to be made. Each year as we go along, they say, well maybe it will work and maybe it won't. This is the lead time. It is not the technical lead time. Because if you had made the decision then, the 46 months would have gone by, you would have had the long lead components, your system would have gone in high gear.

Mr. MCCORMACK. Will the gentleman yield right there?

Mr. HECHLER. Yes.

Mr. MCCORMACK. You mean if the decision had been made then?

Mr. HECHLER. Yes.

Mr. MCCORMACK. You understand the decision is not just purely congressional?

Admiral HAYWARD. No, it is not purely congressional. If the decision had been made then that the United States required a mobile deterrent force of this nature and that you were going to fund it and build it at a rapid rate, you would have those coming out this year at one a month.

Mr. MCCORMACK. As a matter of fact, several of the Polarises have been on the congressional level.

Admiral HAYWARD. Yes, sir, more of them have been added by Congress.

Mr. MCCORMACK. I say that with pride for all Members, without regard to party. My question is not——

Admiral HAYWARD. That is right.

Mr. MCCORMACK. Congress has apparently seen the value of this and has had the vision and the courage to go ahead making appropriations over and above the budget. Is that right?

Admiral HAYWARD. Yes, sir, Mr. McCormack.

Mr. MCCORMACK. Yes. Thank you.

The CHAIRMAN. Any further questions?

Mr. HECHLER. Yes, I have one further follow-up question. Admiral, if the decision were made today on one a month production, how soon could one a month production of Polaris be achieved?

Admiral HAYWARD. If you made the decision right now, you would work up to one a month production in 1963. By the end of 1963, you would have 15 submarines—I had better not go into some of these figures, because they are classified.

Mr. HECHLER. What additional expenditure would this take in order to achieve one a month production?

Admiral HAYWARD. Well, it would take roughly in the 1960 fiscal year about $150 million and in 1961 it would take roughly about $970 million where you went into long lead procurements.

Mr. HECHLER. And you are personally convinced that from the standpoint of national security that one a month production of Polaris would be not only feasible but necessary?

Admiral HAYWARD. Personally, I am convinced that the Polaris system is the best deterrent system that we have in the world today.

Mr. HECHLER. And you would advocate one a month?

Mr. BASS. Would you yield?

Mr. HECHLER. Yes.

Mr. BASS. Just two questions. Did you or Admiral Raborn say earlier that you are still working on an improved version of a Polaris submarine?

Admiral HAYWARD. What we said was that in the 1961 program that we have research and development money looking on—looking to a follow-on system in the Polaris missile, increasing the range, increasing the warhead, you will have a lot of payoffs. Do you want to increase the range; do you want to increase the yield?

You have all manner of things that can be done in this system like any other system. It is going to change over the years; no question about it.

Admiral RABORN. May I amplify. I think I caught the substance of your question.

Mr. BASS. My question really was: Shall we rush into mass construction and production when we perhaps can produce a better version?

Admiral RABORN. You can always produce a better version downstream, if we waited 5 years from now and carry on the work of development that you have, and we plan to have a better one. This is the nature of all weapons; that we do, on an annual basis, improve the quality and performance of all weapons systems as we go along.

Now, you will recall, sir, I think the genesis of your question may have been that I said something about a 1,500-mile system. That is what we started out to build. We planned to bring that out in the calendar year 1965. This was the best when we started out that we thought we could do 4 years ago. We were stimulated and we got into this more, we were stimulated by international events and we saw that we could bring this into being in 1963, that is a 1,500-mile system.

Then, we really were asked to accelerate it and we were well along into our development program we saw we could bring an earlier system with a perfectly usable, approximately 1,200-mile range missile using the same submarine that would use the 1,500-mile missile when it came along later.

So we settled on that. We would bring into being a 1,200-mile missile this year, and this is what we are going to do. It is a perfectly usable weapon. You can hit about 97 percent of all the targets you can hit with a 1,500-mile system. So it doesn't make any sense at all to wait until you get a 1,500-mile bullet to put into this gun. As we go along we will improve the performance of the missile, the bullet, it will fit right into the same chamber, we will walk it out in range and it will allow us to use the broad Atlantic and broad Pacific as our range sites. This is a very desirable thing.

Mr. BASS. Thank you.

Mr. FULTON. I have a unanimous consent request. Mr. Ken Hechler has a minute and a half of his original time remaining, so I have moved that he be given that minute and a half.

Mr. HECHLER. I yield back the balance of my time.

Mr. McCORMACK. I ask unanimous consent that when I am questioning we all forget the clock. Let me watch the clock.

The CHAIRMAN. Let's proceed, gentlemen.

Mr. MOELLER. One question, Admiral Raborn. It is possible, however, that these improvements can be made as the years move on. In other words, you don't have to wait until 1963 or 1965 for these additional improvements.

Admiral RABORN. That is right.

Mr. MOELLER. They are continually being made.

Admiral RABORN. Yes, sir.

Mr. MOELLER. So we can safely say today we can start the program that we will be providing one per month in "X" number of years and all this while these improvements can continue to be made.

The second question I wanted to ask was this: One of the best arguments in favor of the Polaris is the fact that it is mobile and wouldn't be so easily found by the enemy, as, for example, our stationary launch pads, et cetera. Unless this is classified, what defense have you against other submarines? Are you prepared also for this? Is this classified?

Admiral HAYWARD. We are prepared; yes, sir.

Admiral RABORN. It is classified and we are prepared.

The CHAIRMAN. Mr. King?

Mr. KING. Admiral Raborn, at 1,200-mile range, how many of the Russian so-called vital areas could be covered?

Admiral RABORN. I would like to reserve this for executive session if I may, Mr. King. It is a very good question, and I dearly love to answer it.

Mr. KING. Let's remember to bring that up in executive session.

Admiral RABORN. I will recall it. It is sufficient to say right here that it is quite an adequate range.

Mr. KING. Glad to hear that. Continuing, I had one or two other quickies. You mentioned in your prepared statement that the human factors become a substantial limitation on the program or something like that. You didn't amplify the idea. I am sure you know what I am talking about.

Could you expand that just a little?

Admiral RABORN. Yes, sir. We recognize that the endurance of a nuclear-powered submarine is—well it exceeds the nominal alert human response or behavior. So we have two crews in these submarines and we will spell them off one after another, just as you do when you have people on watch in various parts of the ship, we will change the whole crew. Thus, we will keep one crew out there, we hope, in a very alert frame of mind and also keep the high enlistment rate up.

Mr. KING. What is the maximum time of alertness that you have worked out?

Admiral RABORN. This is dependent upon, of course—and that is classified, the exact amount, sir, and I will give that in executive session—but it is dependent on the type of motivation you give the crew, the habitability of the submarine, the way in which they are held by their fellow countrymen. Are we proud of them? It is that sort of a thing.

Mr. King. You did state, I believe, that generally the morale and motivation was very high?

Admiral Raborn. Yes, sir.

Mr. King. This Manhattan-type organization, could you give us just a little background of that?

Admiral Raborn. Well, I would like to because it has been very pleasant to have one. I report directly to the Secretary of the Navy and I have two pieces of paper, one from Admiral Burke and one from the Secretary saying if you have difficulty with anybody bring them to see me. Fortunately we have had no difficulty. The response of the Navy as a whole has been tremendous. I think it is highly complimentary to the Navy's organization that they could take a Manhattan-type organization, operating within it and support it on a wholehearted basis without disrupting, if you please, the nominal business of the Navy.

Mr. King. What are the characteristics of that type of organization?

Admiral Raborn. The characteristics are that I have a job to do and I have a minimum of bosses and I have top priority and I can go into any man's organization in the Navy, and commercial organizations too, with the Presidential No. 1 priority, and get a job done or equipment or things accomplished on a first-call basis. And this is what is meant.

Admiral Hayward. Maybe I can describe it. Admiral Raborn is the General Groves of the Navy. He has all of the appropriations involved. I am responsible for the research and development organization. He has ships and ordnance, ammunition, RDTM, military construction, it is all in his shop. He tells the people what to do, when to do it and where to do it. This is the boss, he is the boss. This is exactly why he is like General Groves. If he wants of course, I don't know in this day and age you can duplicate what General Groves did—to build three plants, but if Red wanted to do it, he could do it. So he is the boss in fact as well as in name.

Mr. Miller. He has to make the decisions?

Admiral Hayward. Yes, sir; and he has the responsibility along with the authority.

Mr. Miller. And he has exercised that, hasn't been afraid to do it?

Admiral Hayward. Yes, sir; he is not redheaded for nothing.

The Chairman. Mr. Roush?

Mr. Roush. Didn't you appear on a TV program last Saturday night?

Admiral Raborn. It was my pleasure, sir.

Mr. Roush. I thought I heard you say during the course of that program that the Russians did not have a submarine similar to the Polaris; is that correct?

Admiral Raborn. That is correct.

Mr. Roush. Is that so? They do not have a submarine similar to the Polaris?

Admiral Raborn. To the best of my knowledge.

Mr. Roush. I thought I had heard Admiral Burke tell us the other day, that they did have.

Admiral Hayward. Yes, sir, but there is a great difference.

You saw the picture of the submarine that was flushed off Iceland some months ago. It was quite obvious that those submarines, when

the Russians went about it, in a simple manner, launch from the surface. They didn't believe a submarine was vulnerable on the surface as much as some of our people did. So they don't have a submarine like the Polaris. They don't have the nuclear submarines.

Mr. ROUSH. I don't believe Admiral Burke amplified his testimony the other day, but I do recall him saying that there was one similar and it had a range of 350 miles.

Admiral HAYWARD. He probably didn't enlarge the fact that it was a surface launch device, launched right from the surface of the sea, didn't do it submerged.

Mr. MILLER. Will the gentleman yield?

Mr. ROUSH. Yes.

Mr. MILLER. We have had the Regulus for quite some time and it was surface launched from submarines and its range was over 300 miles, wasn't it?

Admiral HAYWARD. That is correct.

Mr. MILLER. And we have abandoned that as being a bit obsolete and obsolescent, haven't we?

Admiral HOWARD. Yes. We haven't abandoned it. These submarines are actually deployed and on station now.

Mr. MILLER. I know, but we are not building any more.

Admiral HAYWARD. No, sir; we went to Polarises.

Mr. MILLER. And that is comparable in efficiency to this Russian submarine?

Admiral HAYWARD. Yes, because with a conventional submarine like those equipped with Regulus you have to come up anyway.

Mr. MILLER. That is true.

Admiral HAYWARD. So the Russians think very simply, Mr. Miller, and this was a simple approach to the problem and a good one from their point of view to utilize that particular class which they had.

Mr. ROUSH. Is Project Transit tied to the Polaris submarine in any way, Admiral?

Admiral RABORN. I can answer that more fully in executive session, sir. It is not a matter under my direct control and I have direct control of all navigational matters which are of immediate significance to me.

The CHAIRMAN. Mr. McCormack?

Mr. MCCORMACK. How many Polarises have been built now, for the record?

Admiral RABORN. Submarines, sir?

Mr. MCCORMACK. Yes.

Admiral HAYWARD. There are nine authorized and building, plus two tenders and actually one is commissioned——

Admiral RABORN. We have four in the water, one of which is commissioned.

Mr. MCCORMACK. And how many in the coming budget for the next fiscal year?

Admiral RABORN. Three and long-leadtime items for three more in 1962.

Mr. MCCORMACK. I notice you use the words:

> The Polaris fleet ballistic missile will initially have a range of about 1,200 nautical miles with a capability of carrying a powerful warhead.

Will you tell me what you mean by the word "initially"?

Admiral RABORN. Well, when we were asked to cut 3 years off our already accelerated program, we felt that the state of development of the solid propellent missile would be such that we could get a missile with a range of about 1,200 miles and that is what we then will have.

Mr. McCORMACK. In other words——

Admiral RABORN. But we are going ahead with the main drive toward a 1,500-mile system?

Mr. McCORMACK. In other words, at one time the objective was 1,500?

Admiral RABORN. It still is, but we are doing a takeoff of the mainstream development.

Mr. McCORMACK. I think either Mr. Bass' or Mr. Moeller's questions in that respect clarify it, but that word, "initially," that interests me like the word "overall." That is all.

The CHAIRMAN. Any further questions?

Mr. McCORMACK. No.

Mr. SISK. No questions, Mr. Chairman.

The CHAIRMAN. Now, then, Admiral Connolly, do you care to—as I understand it, you want your statement in the record. Do you care to amplify it in open session?

Admiral CONNOLLY. That is right, Mr. Chairman, I would like it to go in the record.

The CHAIRMAN. If there is no objection, we will place the statement of Admiral Raborn and Rear Admiral Connolly in the record as presented to us.

Admiral CONNOLLY. Thank you, sir.

(The statements above referred to are as follows:)

STATEMENT OF REAR ADM. W. F. RABORN

Mr. Chairman and members of the committee, I welcome this opportunity to give you another accounting of the status of the fleet ballistic missile weapon system, generally known as Polaris. The continuing interest of your committee in the fleet ballistic missile program and concern as to its status is very constructive and healthy.

Late this year, calendar year 1960, the fleet ballistic missile weapon system is planned to be operational and should provide the United States with a unique, mobile, and global weapon system. Delivery of the first operational ballistic missiles and the self-sustaining nuclear-powered submarine is being accomplished in unprecedented time—in fact, as I told you last July, almost 3 years earlier than believed possible when the fleet ballistic missile program was announced in January 1957.

Before telling you in detail where we stand today in our Polaris missile development program, I believe it would be worth while to describe briefly the fleet ballistic missile program and our past efforts—the road over which we have traveled to date and the speed limits observed.

The fleet ballistic missile weapon system occupies an extremely important position in the current and future military posture of the United States, and complements other deterrent forces in being or under development. It is designed to give this country a new military capability—the capability to launch long-range ballistic missiles with powerful warheads from nuclear submarines. The combination of the missile, the submarine with its launching and handling, fire control, and ship's navigation devices, plus specially trained submarine crews constitute the powerful sea element of the fleet ballistic missile weapon system.

In the fall of 1955, the President approved a project to develop a ballistic missile system with consideration to be given to both land basing and sea basing. The Navy created the Special Projects Office and as director, I was charged with the responsibility for technical direction and management of the FBM weapon system development, or more specifically, to engineer the sea application of the Jupiter missile.

For a year, we worked hand-in-hand with the Army, whose job was to develop the Jupiter missile. This was indeed a most harmonious partnership and the Navy gained invaluable technical experience.

Since liquid fuels presented virtually insurmountable problems for shipboard use due to safety, space and launching factors, investigations were soon directed toward the development of a solid propelled missile. Meanwhile, significant advances in solid propellent and warhead research occurred. The state of art of long-range, long-endurance nuclear submarines was also well advanced.

In late fall of 1956, the Navy proposed and was authorized to pursue independently the present FBM system with the solid propellent Polaris coupled to the nuclear submarine. In March 1957, after 3 months of continuous study by an industry-scientist-Navy steering group, the weapon system parameters were established. These parameters were based on the most advanced concepts in state of art and the best technical judgments of attainable improvements within the next decade.

These basic parameters and concepts, aside from minor exceptions, have not been changed after 3 years of effort. New technological advances are being incorporated into production components as they occur and at minimum cost. Growth potential is a built-in feature of the system. The nuclear submarine, the major capital investment in the weapon, had a life of at least 15 years.

Let me tell you briefly what the FBM system in operation will offer to our country. A basic requirement of any missile is that it must be able to reach, with accuracy and effectiveness, most of the important potential targets in the world. The Polaris fleet ballistic missile will initially have an operational range of about 1,200 nautical miles and the capability of carrying a powerful warhead. With this range missile, Polaris is in effect a global military weapon in that in excess of 90 percent of the Earth's surface can be brought within striking distance of this mobile system operating from concealed ocean depths. The FBM submarine will be able to navigate accurately, whether surfaced or submerged, using conventional and greatly advanced navigation devices and techniques. At all times, the FBM submarine will know her location in relation to planned objectives and, thus, the missile can be accurately targeted.

Launching points of the weapon system will be constantly moving about so that they cannot be pinpointed in advance by an enemy. The Polaris weapon system is virtually immune to surprise attack and invulnerable to enemy long range missiles because it possesses real mobility. This is fundamental, the ability to operate from one concealed area now and from another hidden area somewhere else one hour later.

As the *Nautilus* and her sister ships have demonstrated the highly mobile, nuclear submarines can remain submerged for extended periods of time, either relatively stationary or cruising over vast ocean areas.

Any retaliatory system to have maximum effectiveness must possess fast reaction time. The solid-fueled Polaris missile will always be ready for firing without protracted delays for preparation. This is characteristically true of missiles with solid propellants.

Polaris deployed in submarines, unobstrusively cruising the oceans removes these weapons from inhabited areas to the seas. It poses an insurmountable intelligence problem to the enemy since every unidentified submarine is a potential Polaris launcher.

Thus, the enemy's countermeasure problems and problems of defense are compounded and complicated. The system presents to any potential aggressor an unquestioned and continuing capability, one which can be comprehended and appreciated.

Because of the threat of deliberate and inevitable retaliation from these concealed mobile launching platforms, the Polaris system should prove a powerful deterrent to any potential aggressor from striking the first blow. With this system, the United States will have a unique global military capability which complements our other retaliatory weapon systems, and which will be under the control of the United States.

Development of this global military capability has been most rapid. In January 1958, the Navy announced an accelerated development schedule with the 1960 target date for initial operational availability. At that time, we were well ahead of schedule and could confidently proceed at a stepped-up pace. Essentially, it was recognized that to meet the accelerated and augmented schedule we would have to resort to all possible means of expediting the work, through shortcuts, and maximum but sensible use of overtime.

Multishift operations and extended workweeks for specified periods were authorized for various shops at contractors' plants to assure that components of the subsystems were all available to dovetail into a fully operable system when needed.

The centralization of responsibility for all aspects of the program under the Special Projects Office as the single weapons system manager, unquestionably facilitated the development effort. With surety, the component parts of the development program have been managed and monitored in unison to meet our operational goals. This includes, in addition to the weapon system itself, the related elements such as production and operational support. The industrial base, logistic facilities and skills essential to support an expanded FBM force have largely been established. The industrial capacity is that necessary to support the presently authorized force, but is also an excellent base on which to build as desired.

The Polaris ballistic missile is a relatively small, compact, solid-fueled missile. A small but highly accurate guidance system had to be developed and simultaneously, made compatible with the missile and the shipboard fire control system. The reentry body represents advanced technology. We have led the way in the harnessing and control of solid propellent motors, use of jetevators for missile flight path control, and means of precise thrust termination to impact on target. We must, of course, continue our development tests to attain the required degree of reliability and to achieve our ultimate system as contrasted with our initial operational objectives. Production of components for the tactical missile is proceeding satisfactorily.

Our flight test program has continued with very gratifying results. Through February 10, 1960, out of a total of 51 flight tests of various types, our technical staff and advisers have rated 35 completely successful since all specific technical test objectives were achieved. These fully successful flight tests included launchings of two-stage solid fuel test vehicles in August 1959 from a shore-based ship motion simulator and at sea from the U.S.S. *Observation Island*, the FBM weapon system test ship. The first fully guided flight was conducted with excellent accuracy on January 7, 1960. Fourteen of the fifty-one flight tests were rated partial successes in that one or more of the primary technical objectives were met; two were failures.

In other words, since I appeared before you last July, we have had 18 flight tests and the score is 11 fully successful flight tests; 7 partially successful. Twelve of the flight test vehicles fired in recent months are more fully representative of the tactical missile. On these our record is 9 out of the 12 fully successful with 3 partially successful.

What this means is that the solutions we devised and corroborated through our ground test program in the fall of 1959 to correct certain deficiencies brought to light through tests in a flight environment are proving to be adequate. As we move more rapidly into the advanced testing stages we may encounter new problems but with our experience backlog, I sincerely believe that as they occur they will be temporary and susceptible to immediate correction by our competent team. We are on schedule, and in a number of cases, ahead of the development challenge established 3 years ago.

The missile flight test program is the most spectacular of all the Polaris system tests. Our approach has enabled us to take advantage of partial successes and failures in ground tests and in flight to arrive at a complete understanding of unanticipated phenomena, and to utilize our successes in flight to make tremendous strides in proving features of the tactical missiles. Let me review briefly the 12 advanced development model flight tests conducted since last July. In September 1959 we fired the first of these from the flat pad at Atlantic Missile Range and performance was almost identical to that specified in the specific technical objectives. The reentry phase of the flight was highly successful.

In October, we fired the second vehicle but the flight was terminated shortly after the second stage motor ignited due to difficulties in the motor. The third vehicle was flown successfully in November, again with excellent reentry body performance. During December, we conducted three additional flight tests. In each instance, the vehicles were launched perfectly, and one performed exactly as predicted. In one case, first stage powered flight through first separation was good until the igniter adapter malfunctioned (a random type failure), and suddenly terminated flight. In another case the vehicle veered off course and the Range Safety Officer destroyed it.

In January we have had four fully successful tests. On January 7, 1960, we conducted our first fully guided flight test. Performance of the guidance system was outstanding. May I state that the guidance system, in every preceding ground test and as a passenger in several of the flight test vehicles, has operated successfully. In this test, utilization of our radically new fire control system was made and similar fire control systems are being installed in the FBM submarines. Satisfactory performance provides another degree of confidence that our integrated weapon system will have the required accuracy. The other full-scale flight test vehicles successfully flown in January and on February 4 and 10 provided further assurance of guidance operation and accuracy, reentry body design, and integrity of the missile as a whole.

Remarkable progress continues to be made in our launcher development program. Last July I showed you pictures of the ingenious devices used to prove out the feasibility of underwater launching and the compatibility of the missile and launching tube. At San Francisco Naval Shipyard, we have Operation Skycatch and Peashooter, dry land launching facilities to test various methods of ejecting the missile from the tube. At San Clemente Island, Calif., Operation Pop-Up and Fishhook have repeatedly demonstrated the feasibility of underwater launching of full-size missiles, and of stable travel of test vehicles through and out of both calm and turbulent water. Skycatch and Fishhook are devices with the capability of arresting the test vehicle in midair which means the vehicle can be reused time and again. Tests at the two launcher facilities will continue to pioneer further developments in launching methods and devices.

All aspects of the FBM ship construction have progressed satisfactorily under the accelerated schedule. Four FBM submarines were launched during 1959; the USS *George Washington* at Groton, Conn., on June 9; USS *Patrick Henry* at Groton, Conn., on September 22; USS *Theodore Roosevelt* at Mare Island, Calif., on October 3; and the USS *Robert E. Lee* at Newport News, Va., on December 18. The USS *George Washington* was commissioned on December 30. With a Navy crew in charge, the USS *George Washington* is now undergoing an extensive installation test program and other required tests and trials preliminary to the first live missile firing later this year. The program of dummy missile shots from the ship was successfully completed prior to December 30, 1959.

The USS *Observation Island*, the FBM weapon system test ship, has recently been equipped with additional prototype equipments, and will shortly resume operations at sea.

A submarine tender is being converted to provide afloat maintenance for the FBM submarines and will be available for service in late 1960. A second tender new construction, is in initial stages of construction.

Important shore facilities, which are an integral part of the FBM program include the Missile Assembly facility at the Naval Weapons Annex, Charleston, S.C., and a team trainer at the submarine base, New London, Conn. These facilities will be fully operational when needed to support the FBM operational capability. Of course, we have had to supplement the facilities at the Naval Test Complex at Cape Canaveral, Fla., to accommodate the progressively advanced Polaris experimental test vehicles.

Additionally, port facilities have been provided at Cape Canaveral to support the FBM ships prior to conduct of shipboard missile firings down the Atlantic Missile Range.

The FBM program is being developed and managed as a complete program package under authority delegated to the Special Projects Office. The program from its inception has been reviewed and approved in total terms which permit completely integrated and balanced planning and administration by the director and his departmental staff of less than 250 military and civilians. As part of our approach to the development of the FBM weapon system in the spring of 1957, we spent considerable time in planning and scheduling our program. The Special Projects Office devised a management system with the following objectives: to organize facts for complete decisions and staff actions, to provide a basis for accountability of performance on approved projects and a "need-to-know" reporting system and to provide a framework for responsible and objective evaluation of progress. We explored and developed new management techniques, including a system generally known as PERT (Program Evaluation and Research Technique utilizing a digital computer) which has been widely utilized in whole or in part by other services and private industry for the purpose of research and development management. These efforts have kept the

status of the FBM program known at all times, including how our funds are used. Problem areas can be readily identified before they become critical, and we have a factual basis on which to make the numerous day-to-day management decisions attendant to such a large complex program.

In summary, the FBM program has forged ahead with sophisticated developments on a very tight time schedule. An advantage has been a top priority rating, co-equal with the other major missile programs of the Department of Defense. Based upon performance to date and an intimate knowledge of the work yet to be accomplished, the Polaris submarine weapon system with its allied operational and logistical support is planned to be available operationally this year with the readiness of the USS *George Washington*. Other submarines are planned to be deployed at intervals, with a total of 9 Polaris submarine systems expected to be ready in a timely manner. Moving at will within the safety of the ocean depths, the Polaris submarine can be expected to accomplish her mission.

STATEMENT OF REAR ADM. T. F. CONNOLLY, ASSISTANT CHIEF, BUREAU OF WEAPONS, PACIFIC MISSILE RANGE AND ASTRONAUTICS, DEPARTMENT OF THE NAVY

Bureau of Naval Weapons Organization for Space

The Bureau of Naval Weapons organization for space is shown on the accompanying chart. Under the Secretary of the Navy and the Chief of Naval Operations, the Assistant Chief of the Bureau of Naval Weapons for Pacific Missile Range and Astronautics provides a specific point of contact for coordination or progress which are being conducted under the management of the Bureau and its various field activities. (Chart 1.)

Basic organizational planning for the Bureau of Naval Weapons provided for the ready adaptation and direction of weaponry in the advanced space technology field. Although the major weapons development area in the Bureau of Naval Weapons organization is under an Assistant Chief for Research, Development, Test, and Evaluation, other line operating Assistant Chiefs are assigned to areas that include contracts, production and quality control, fleet readiness, and field support. Included in the Staff Assistant Chiefs is the Assistant Chief for Program Management to whose office the Assistant Chief for Pacific Missile Range and Astronautics is attached.

The Assistant Chief for Program Management, in addition to being placed in staff capacity to the Chief, also participates in a verticality of reporting lines involving the line Assistant Chiefs, including that for Research, Development, Test, and Evaluation, where management of major bureau programs is the order of business.

In weapons development and procurement, the Assistant Chief for Program Management essentially outlines what is to be accomplished, along with timing guidelines. He is responsible to the Chief of the Bureau of Naval Weapons for planning and executive direction of all Bureau programs, including the assignment of resources for their accomplishment. It is then the responsibility of other line Assistant Chiefs to perform timely development and production, furnish progress reports, and work out program changes and modifications of requirements or objectives.

Such a basic organizational pattern was devised as the best possible approach to workable management of the activity which would give functional grouping of skills and knowledges pertinent to research and development, materials management, and field support; to provide maximum vertical management with flexibility to meet shifting technological and business emphasis; to provide feedbacks enabling program reviews; and to keep at a minimum the numbers of people reporting to the Chief, Bureau of Naval Weapons.

Also attached to the Assistant Chief for Program Management are two Assistant Chiefs within this organization, the Assistant Chief for the Pacific Missile Range and Astronautics, and the Assistant Chief for Program and Management Plans.

The Assistant Chief for Pacific Missile Range (PMR) and Astronautics programs is responsible within the organization of Assistant Chief for Program Management for overall coordination, policy, and executive direction and administration of all plans and programs within the Pacific Missile Range and

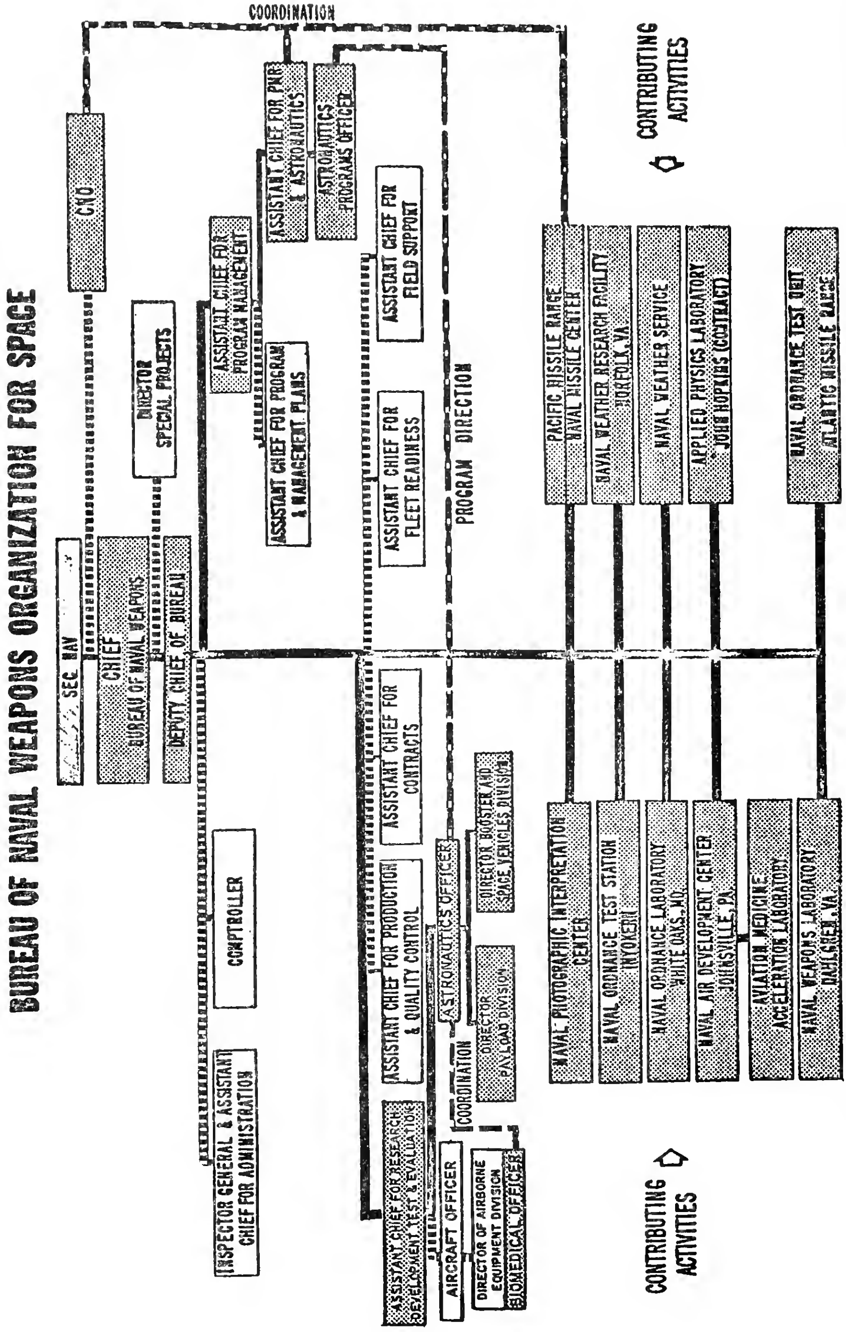
BUREAU OF NAVAL WEAPONS ORGANIZATION FOR SPACE
COORDINATION
CNO
SEC NAV
CHIEF BUREAU OF NAVAL WEAPONS
DEPUTY CHIEF OF BUREAU
DIRECTOR SPECIAL PROJECTS
ASSISTANT CHIEF FOR PROGRAM MANAGEMENT
ASSISTANT CHIEF FOR PMR & ASTRONAUTICS
ASTRONAUTICS PROGRAMS OFFICER
ASSISTANT CHIEF FOR PROGRAM & MANAGEMENT PLANS
ASSISTANT CHIEF FOR FIELD SUPPORT
ASSISTANT CHIEF FOR FLEET READINESS
PROGRAM DIRECTION
INSPECTOR GENERAL & ASSISTANT CHIEF FOR ADMINISTRATION
COMPTROLLER
ASSISTANT CHIEF FOR CONTRACTS
ASSISTANT CHIEF FOR PRODUCTION & QUALITY CONTROL
ASSISTANT CHIEF FOR RESEARCH DEVELOPMENT TEST & EVALUATION
ASTRONAUTICS OFFICER
DIRECTOR BOOSTER AND SPACE VEHICLES DIVISION
DIRECTOR PAYLOAD DIVISION
COORDINATION
AIRCRAFT OFFICER
DIRECTOR OF AIRBORNE EQUIPMENT DIVISION
BIOMEDICAL OFFICER
PACIFIC MISSILE RANGE
NAVAL MISSILE CENTER
NAVAL WEATHER RESEARCH FACILITY NORFOLK, VA.
NAVAL WEATHER SERVICE
APPLIED PHYSICS LABORATORY JOHN HOPKINS (CONTRACT)
NAVAL ORDNANCE TEST UNIT ATLANTIC MISSILE RANGE
CONTRIBUTING ACTIVITIES
NAVAL PHOTOGRAPHIC INTERPRETATION CENTER
NAVAL ORDNANCE TEST STATION INYOKERN
NAVAL ORDNANCE LABORATORY WHITE OAKS, MD.
NAVAL AIR DEVELOPMENT CENTER JOHNSVILLE, PA.
AVIATION MEDICINE ACCELERATION LABORATORY
NAVAL WEAPONS LABORATORY DAHLGREN, VA.
CONTRIBUTING ACTIVITIES

CHART 1

Astronautics area of cognizance. As such, he provides a specific point of contact for coordination, guidance, and assignment of resources to astronautics programs which are being conducted under the management of the Bureau of Naval Weapons.

The Assistant Chief of the Bureau for Research, Development, Test, and Evaluation is directly responsible to the Chief of the Bureau for the complete development of aircraft, weapons, and associated equipment with program management and direction in the astronautics area being the responsibility of the Assistant Chief for Pacific Missile Range and Astronautics. Under the Assistant Chief are four subgroups charged with the development of systems and components in the areas of aircraft, missiles, antisubmarine warfare, and astronautics. The astronautics subgroup consists of two divisions, payloads and vehicles, from which the Navy navigational and biomedical programs are being prosecuted.

PACIFIC MISSILE RANGE HISTORY, MANAGEMENT, AND OPERATIONAL CONCEPTS

History

The Pacific Missile Range (PMR), managed by the Navy, is one of the three national missile ranges, each having unique capabilities and different but complementary missions. The PMR mission is to provide range support for the Department of Defense and other designated Government agencies in guided missile, satellite, and space vehicle research, development, evaluation, and training programs in the Pacific Ocean area.

The PMR had its inception in December 1957 as a result of increased emphasis on missile and satellite programs and recognition of the necessity for adequate range facilities. The Naval Missile Center, Point Mugu, is the nucleus upon which the full Pacific Missile Range is being developed. This center, an operating missile range for 12 years, is manned by over 5,000 military and civilian personnel who are thoroughly trained and experienced in range operations. Its major complex before expansion consisted of a 75- by 150-mile sea test range off the coast of California. In this area the Navy had conducted thousands of tests of conventional types of guided missiles. The development and testing of these types of Navy missiles will continue at the Naval Missile Center with the Pacific Missile Range providing all the range support.

In June 1958 the PMR was officially established as a national facility with the Navy as executive agent. The Point Arguello area is being developed primarily in support of national astronautics and space effort, since it contains many deep canyons wherein large, dangerous noisy rockets can be isolated, plus a unique east-west coastline which allows firings into polar orbit without passing over any land between Point Arguello and the South Pole, thus making this area the most desirable rocket launching center on the U.S. mainland for launching satellites into these orbits. In addition, Arguello provides range services to launchings from Vandenburg Air Force Base to the north and to missile flights in the adjacent Pacific areas.

Operational concepts

The Navy has reviewed all firm missile and space programs requiring PMR support in order to prepare a long-range plan for future development of the range. This plan involves the establishment of a complex of ranges, capable of supporting the various types of missile and satellites to be developed. This complex includes: (*a*) A 250-mile sea test range, (*b*) a 1,500-mile IRBM range, (*c*) over 5,000-mile ICBM range terminating near Eniwetok Island, (*d*) a polar orbit range originating at Point Arguello, and (*e*) an antimissile range in the Kwajalein Atoll in support of the Army's Nike-Zeus antiballistic missile program which will provide capability for testing antimissile missiles, using as targets ballistic missiles fired from the Vandenburg Air Force Base on the west coast and from Johnston Island.

Under strong naval management, the Pacific Missile Range utilizes three contractors for specialized technical range operations and development areas—one in the eastern Pacific and another in the western Pacific. The third major range contractor is in the range development area to help assure that the range will expand in a planned and organized manner, anticipating and being ready for the demands placed upon it. This contract system was evolved after careful and detailed studies of the contract operations of the other national ranges. This study concluded that a single range contractor operation was undesirable because such an overall operation control might take over the management

control function which is properly the responsibility of the range commander. Conversely, it was determined that to go to a system utilizing a large number of small contractors, could prove to be a major management headache. The Pacific Missile Range tricontractor system appeared to be a sound, logical, middle-of-the-road approach and is meeting with excellent success.

The CHAIRMAN. All right, then, if there is nothing further, we can move into executive session at this point.

(Whereupon, at 11:15 a.m., the committee proceeded in executive session.)

(The executive session is classified and will not appear here.)

REVIEW OF THE SPACE PROGRAM

MONDAY, FEBRUARY 15, 1960

House of Representatives,
Committee on Science and Astronautics,
Washington, D.C.

The committee met at 2:30 p.m., Hon. Overton Brooks (chairman) presiding.

The Chairman. The committee will come to order. I have a note here from Mr. Wilcove, our consultant, that Mr. George M. Low, who was due to testify as to the Mercury project, is sick. He will not be present to testify. So we have now Mr. Richard V. Rhode, assistant director of research, and Maj. Victor W. Hammond, Air Force tracking and data acquisition program of NASA. I think that is it.

Mr. Fulton. May I welcome them both, too.

Mr. Rhode. Thank you.

Mr. Fulton. Glad to see you here.

The Chairman. We are happy to have you, gentlemen. Mr. Rhode has a prepared statement here. I would suggest, Mr. Rhode, that you proceed with your prepared statement.

Mr. Rhode. Thank you, Mr. Chairman.

STATEMENT OF RICHARD V. RHODE, ASSISTANT DIRECTOR OF RESEARCH, NASA

Mr. Chairman and Members of Congress, many problems in applied research and technology must be solved before we can accomplish our future, more advanced space missions. A great deal of knowledge has to be obtained through the research process in order to establish the facts required to make a sound judgment as to the feasibility of any development project. To proceed with development in the absence of such knowledge means that we must pin our hopes on assumptions born of ignorance.

I can assure you, gentlemen, that this can be an extremely costly process.

In order to illustrate our research activity, let us consider a space mission designed for manned circumnavigation of the Moon (fig. 109, p. 662).

I call your attention to the charts on the side wall. I am sorry the physical limitations of the room prevent me from getting up to the charts myself. I have asked Mr. Goranson to handle the charts for me. I am now speaking to the first chart.

This lunar mission entails launch and exit from the atmosphere, space flight, orbiting the Moon and exploration of the lunar surface, and finally, return to Earth, entry into the Earth's atmosphere and landing. The first phase of this or any other mission is launch and exit from the atmosphere (fig. 110, p. 662).

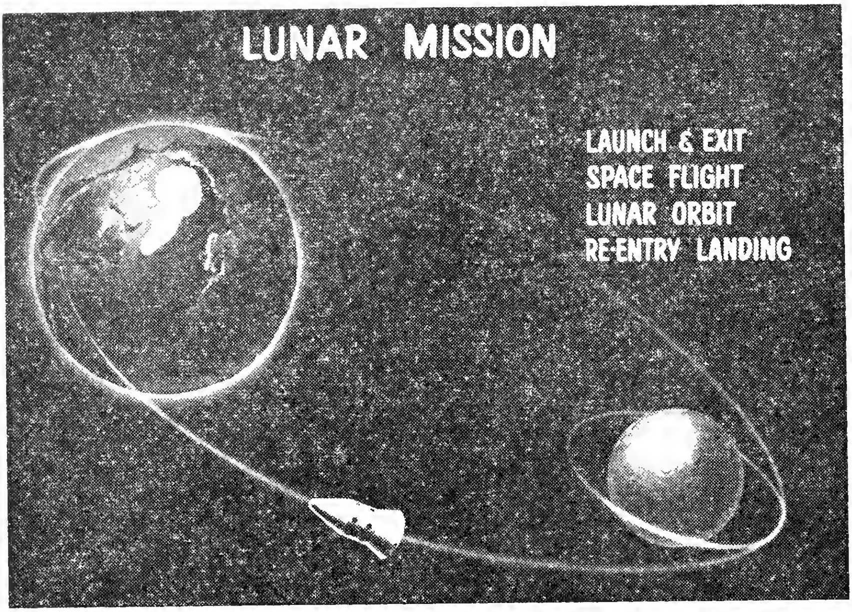

FIGURE 109

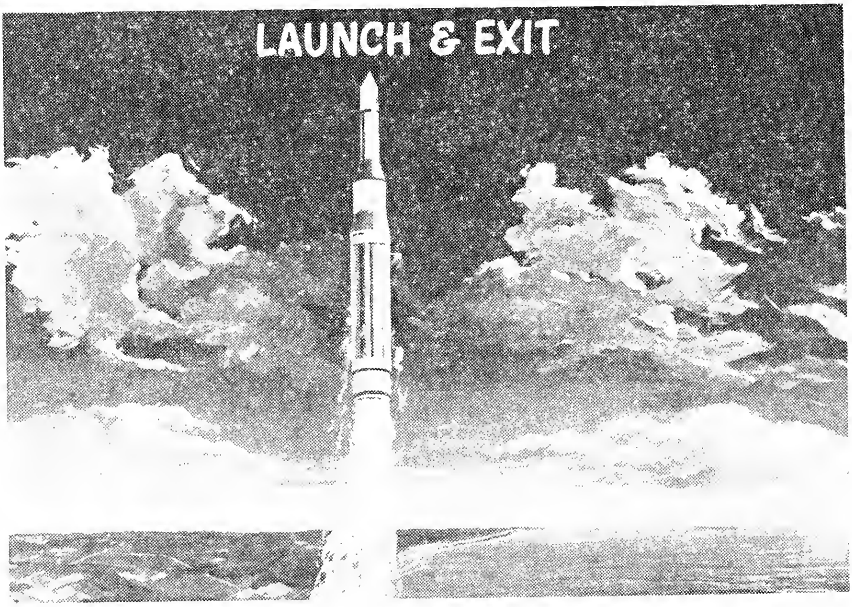

FIGURE 110

LAUNCH AND EXIT

This manned lunar mission will require a large main booster, such as Saturn, with suitable second stage and other boosters, and a payload consisting of a space craft and reentry vehicle together with their contents. Such a system is large and heavy. The length may be 300 feet and the weight a million pounds. Because of the great importance of weight, the structure will be light and flimsy by normal structural standards. On the other hand, the volume and weight of the fuel will be large. The system will be balanced on and accelerated by rocket engines having a total thrust of 1.5 million pounds, and it will be subject not only to the force of thrust along the axis, but also to side forces caused by winds and turbulence and to the corrective sidewise components of thrust from the gimbaled engines.

With such a system, having large weights and forces and a light structure, there is a very difficult problem of vibration or system dynamics.

One aspect of this problem is the interaction between the control system and the flexible structure. This aspect, which is called structural feedback, can be demonstrated by a simple model. The model, you will note, is on my left.

The control system consists of a device sensitive to motion, called a sensor, which transmits a signal to a control element. Here, the sensor is a simple accelerometer and the control element is an electro-magnetic device which causes side forces similar to those caused by the gimbaled engines. When the sensor is moved by hand, the control device also moves and causes the structure to respond.

I should like to interpolate a remark here just so you will understand that the only time that the force representing that from the gimbaled engines goes into action is when the sensor is moved. There is no external force applied. This electro-magnetic device must be regarded as a part of the system.

I call your attention to the fact that the control device is designed to shift the attitude of the machine to exert proper control, and if the machine were a rigid body, it would do so. The thing about it is that the body actually does have structural flexibility so that when the control element seeks to cause the vehicle as a whole to change its path, it does set up those structural deformations which you have just seen.

The CHAIRMAN. Show us where the gimbaled engines would be.

Mr. RHODE. They would normally be at the bottom. If you will refer to the chart you will see the engines at the bottom of the chart with the exhaust gasses coming out of them. These engines are normally mounted on swivel bearings so that the direction of thrust can be changed to cause corrective sidewise forces in the system.

Now, when the sensor is moved by hand, the control device also moves and causes the structure to respond.

In practice, the sensor must, of course, be located somewhere in the system. Suppose we mount it amid-ships and then see to it that the model is disturbed in the same way that it might be disturbed when encountering a gust in flight. Now, you see that it keeps on shaking. The response of the structure is considerable and in practice this much vibration would destroy the vehicle. It does not die out and is therefore called unstable. The shape of the axis as it bends back and forth

in the demonstration is typical of a simple bending vibration. Now, let us see what happens when the sensor is placed at the nose [indicating]. You see what a more complex form of vibration is excited. That was the third mode, as we say.

One can readily see that the interaction of a control system and a flexible structure poses a problem.

As previously noted, the system contains a large mass of fuel, and the demonstration has shown that vibratory motions will cause the fuel to slosh around in the tanks, thus setting up additional large and irregular forces. This is one aspect of the problem that gives us considerable trouble, so that we have brought along with us a short movie sequence showing studies being made of fuel sloshing in the laboratory. You will first see a transparent tank with colored fuel reacting to controlled forces. This will be followed by a demonstration of the effectiveness of baffling. The gimbaled engines are simulated by an air jet at the bottom of the tank. Now—can we get that in better focus?

The operator is putting a simple baffle in the tank now. You see that the fuel does not now slosh around particularly, and the motion damps out.

These and other facets of the booster-system dynamics problem are being actively studied at our research centers by both experimental and mathematical techniques. We will have to continue to do so for some time to come, because the problems become both more serious and difficult as the systems become larger.

SPACE FLIGHT

Once the vehicle has been successfully launched into space, many new problems are encountered. Among them are the hazards of the space environment, such as meteoroids, and problems of guidance and attitude control of the spacecraft. Let us consider first the meteoroid problem (fig. 111).

Meteoroids are metallic or stony bodies that travel through space at speeds estimated to range between about 25,000 and 165,000 miles per hour. Many of these meteoroids are very large, such as the one you see in the movie, that caused the craters on the Moon or the one that fell in Arizona centuries ago to create the well known meteor crater there. Others are very small.

Fortunately the large ones are extremely rare. For example, the surface of the Moon has not been visibly changed by these large-scale meteoroid impacts since the invention of the telescope. We don't worry about these large meteoroids any more than you do when you walk down the street.

The small ones, however, are quite frequent in occurrence in space and the probability of an impact by one of them on a space craft becomes quite large. In fact if there were no atmosphere surrounding the earth we would all be likely targets for them.

These small meteoroids may be only a few thousandths of an inch in diameter.

Although very small, they can, because of their tremendous speeds, be very destructive. It has been estimated, for example, that a ball in space made of aluminum about one yard in diameter and having a thickness of .005 inch might be punctured as often as once every ten

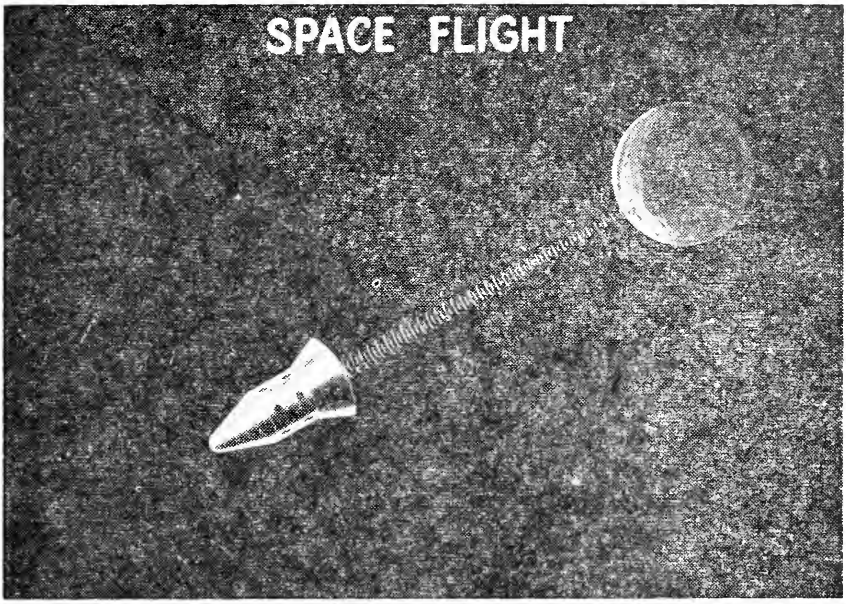

FIGURE 111

hours or twice a day. With ten times this thickness, the ball might be punctured once every 200 days. Obviously, light structures, including tanks and radiators, will not give satisfactory service over a long period of time without some protection against meteoroid strikes.

One way to study this problem is to shoot small particles at high speeds at test specimens and see what happens. We have been doing this for some time.

The photograph shows two high speed helium or light-gas guns developed at our Ames Research Center. Some of you, I understand, have seen them (fig. 112, p. 666).

They can shoot small balls about one-sixteenth of an inch in diameter as fast as 14,000 miles per hour. This speed is much faster than a rifle bullet—a typical military rifle, for example, shoots at about 2,000 miles per hour. We can obtain much useful information from such equipment, because by using relatively large pellets we can obtain the same impact energy as the smaller meteoroids have. Meanwhile, we are studying means for shooting smaller particles at speeds within the meteoroid speed range.

This next chart shows, on the left, the crater made by an actual meteoroid impact on a sounding rocket. It occurred at about 90,000 feet altitude within the atmosphere; consequently, the meteoroid must have been greatly slowed down from its original speed by the atmosphere above this level. The rocket itself was traveling at only about 3,000 miles per hour. The impact was therefore much slower than those we expect to encounter in space. Nevertheless, the incident is of great interest in demonstrating that impacts actually do occur, and in providing a rough comparison with laboratory impacts.

This is a photograph made in an NASA laboratory of an impact crater made by shooting a small steel sphere at a copper target. You

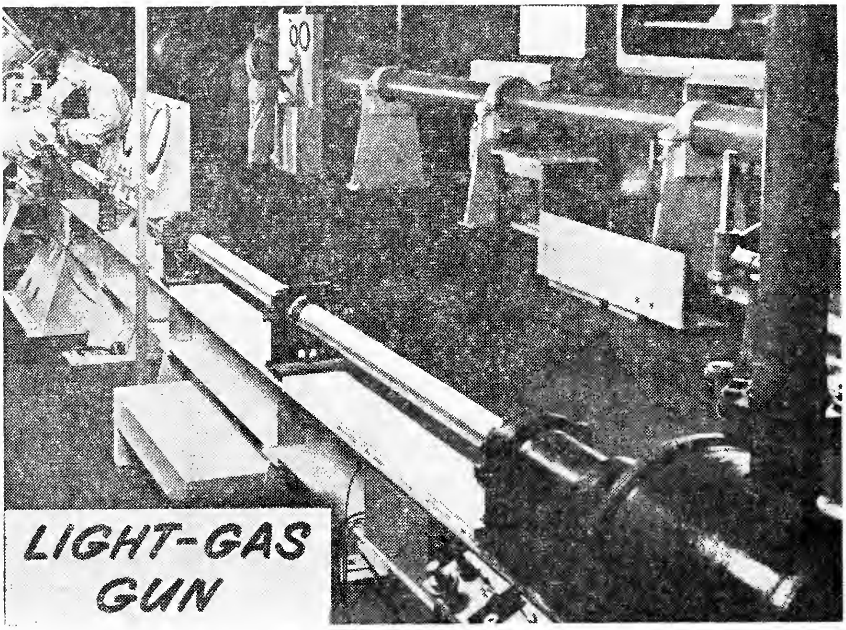

FIGURE 112

have probably seen such pictures before. This comparison simply shows the similarity of the two craters—one made by a micrometeoroid in space—the other by a particle shot from a gun in the laboratory (fig. 113).

I wish to call your attention here that the comparison is between the pockmark on the right and the central crater in the picture on the left. The marks surrounding the central crater were presumably caused by material which had melted or peeled off of the meteoroid proper, as it was coming through the atmosphere. The main body of the meteor hit in the center of that photograph and these peeled-off or melted parts hit around the crater proper.

One of the possible ways of handling the meteoroid threat is to build a light shell or "bumper" around the spacecraft. The thought here is that the particles are going so fast that when they strike the bumper they will disintegrate before striking the underlying structure. An idea of the possible effectiveness of such a bumper is shown in the next chart.

These are results of some studies made with one of the guns shown in the photograph you saw a moment ago.

The figure (fig. 83) shows the speed in miles per hour required to just penetrate the target with $\frac{3}{16}$-inch-diameter Pyrex spheres. We see that a pellet going at 2,000 miles per hour or nearly so will go through a single thick sheet. But if the sheet is split and separated a bit, it takes a speed of 4,000 miles per hour to go through. With four layers, again of the same total weight, we can withstand somewhat greater speed. Now, if we fill the space between the bumper and the second sheet with low-density glass wool, we see that particles going as fast as 7,000 miles per hour will be stopped. These tests simulate

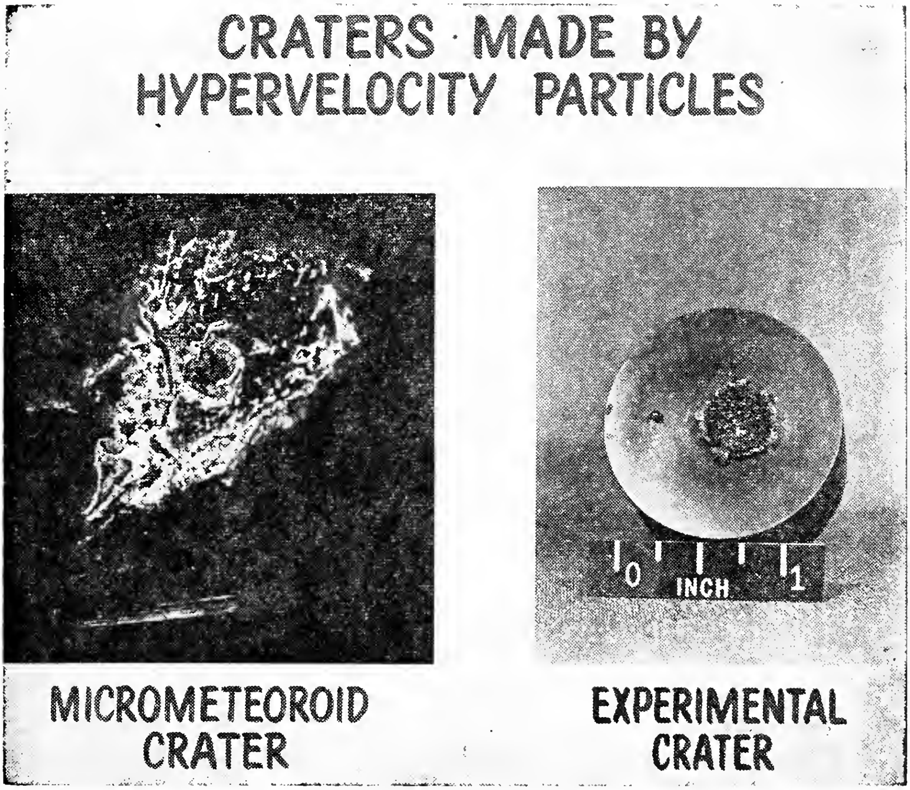

FIGURE 113

what would happen with meteoroids $\frac{1}{16}$ of an inch in diameter at speeds of about 40,000 miles per hour—well within the meteoroid speed range (fig. 114, p. 668).

Now, these results and conclusions I have just shown you are based on laboratory tests, and of necessity contain some assumptions and approximations. For this reason we would like to get some direct and actual data from real meteoroids. To do this, we plan to send up a test satellite this year on one of our first Scouts to test out the theories and laboratory results.

This model before me is a one-fifth scale model of the puncture experiment satellite. These segments of tube that you see here running lengthwise will be made of metal of various thicknesses and will contain gas under pressure. This, incidentally, is a full-sized tube of the kind I am now discussing.

When a tube is punctured by a meteoroid, the gas will leak out and this occurrence will be radioed back to Earth.

There is a pressure sensitive instrument in here that is hooked up with the radio system and the message is transmitted through these antennas. In this way, we will get direct information on how long a structure made of material of different thickness can be expected to last out in space. In the future, we will get more and more

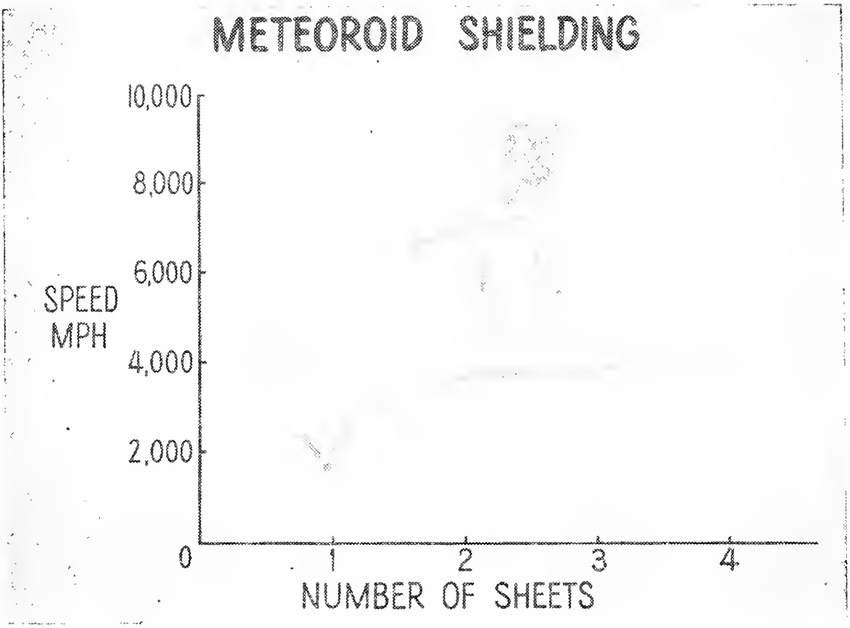

FIGURE 114

direct information of the sort that will enable us to design better and more efficient spacecraft.

Another problem of space flight is that of guidance and attitude control. I shall now review a few aspects of this problem.

Many satellite and other space missions, such as our lunar mission, require that the attitude of the spacecraft be maintained or stabilized (fig. 84). On this next chart are shown some typical requirements of attitude control. Earth satellites might be required either to continue to point toward the center of the Earth or to continue to point toward a fixed object in space (fig. 115).

Note, for example, that the Nimbus satellite, which is the meteorological satellite, always has to point toward the center of the Earth. On the other hand the satellite bearing the astronomical telescope will always have to point toward a fixed object in space. Space probes or spaceships taking navigation fixes must, in general point toward some fixed object in space.

Different missions require different degrees of precision. Earth-oriented communications and meteorological satellites require very little precision—the attitude need be maintained only within about 8° for the former, and within about 1° for the latter. Space-oriented spacecraft however demand a very high degree of precision. Interplanetary navigation, for example, requires that the attitude be stabilized within about 0.005°, and the astronomical satellite must be stabilized to the very fine point of 0.0003°. In order to give you some idea of what this means, 0.0003° is the angle contained between two straight lines starting at a point in this room and spreading only 70 feet apart in San Francisco.

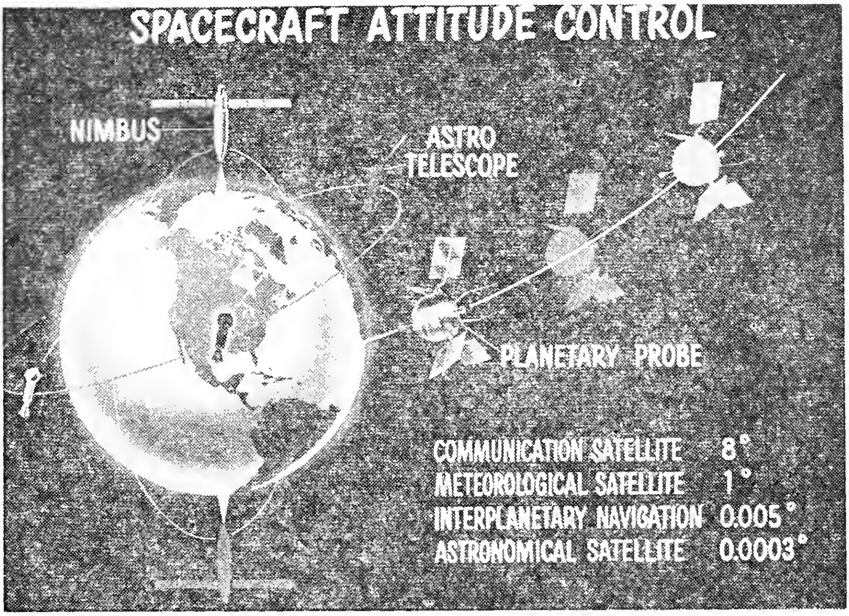

FIGURE 115

Spacecraft stabilization systems may differ in the specific means employed to do the job. All of them, however, must employ mechanisms of one kind or another to perform the required functions. These functions are to sight on some reference point, such as the lunar horizon or a star; to analyze the information from this sighting system or sensor, and finally to activate a suitable control device in order to maintain the proper attitude of the spacecraft.

I have here a simple demonstration model of an attitude control system. The spacecraft is represented by the turntable, which is quite free to rotate just as the spacecraft is free to rotate about any of its three axes in space. The sensor is a simple photoelectric cell. Its signals actuate the control device, which, in this case, is an inertia wheel that operates on the principle of conservation of angular momentum, if I may use a technical term.

Now, you will see that as the turntable is spun slowly the light beam will capture the system and stop its motion and it will continue to follow the light beam no matter where the light beam might be (fig. 116, p. 670).

All of the mechanism for doing this is contained on the turntable. There is no external force applied to cause it to do what you just saw. Now, in order to obtain the required precision, each one of the functional requirements must be subjected to the research process such as indicated by the work going on in the laboratory setup shown on the next chart.

For example, if as is likely, the sensor is a light-sensitive mechanism, its sensitivity and accuracy must be investigated in relation to the wavelengths available in the light source; some of the wavelengths may have to be filtered out. Again, control mechanisms of various

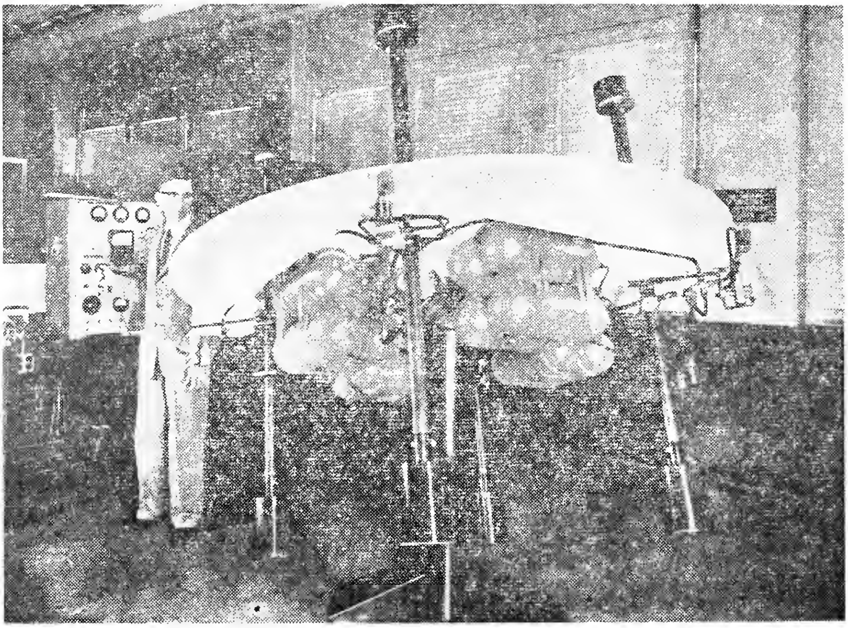

FIGURE 116

types must be investigated to determine the principles best suited to the development of controls having low power requirements and at the same time high positioning accuracy. These and many other problems are being investigated with laboratory equipment such as shown on this chart.

Progress to date indicates that we can achieve an accuracy of three-hundredths of a degree with present laboratory equipment, and that 1½ hundredths of a degree can be achieved before long. Further research is obviously required in order to develop the high accuracies required for space-stabilized systems, such as the five-thousandths of a degree and three-ten thousandths of a degree figures I mentioned earlier.

The third phase of our assumed mission is to circumnavigate the Moon and conduct the necessary exploratory activities. We would expect the men aboard the spacecraft to be taking moving pictures, television pictures, and performing other observations. This gets us into the question of weightlessness and whether men can perform the required duties in a gravity-free environment. As this question of zero g. has been touched on by others and will later be gone into by Mr. Low, I shall not go into it.

Another aspect of lunar exploration (fig. 117) is the matter of sending instruments to the lunar surface and to have them remain intact so that they can transmit information either back to the spacecraft or to Earth. To do so requires ejection of a lunar-landing system (fig. 118) and instrument package from the spacecraft, arresting its forward motion and placing it on the Moon intact, such as is indicated schematically on the chart. In principle, there are several ways

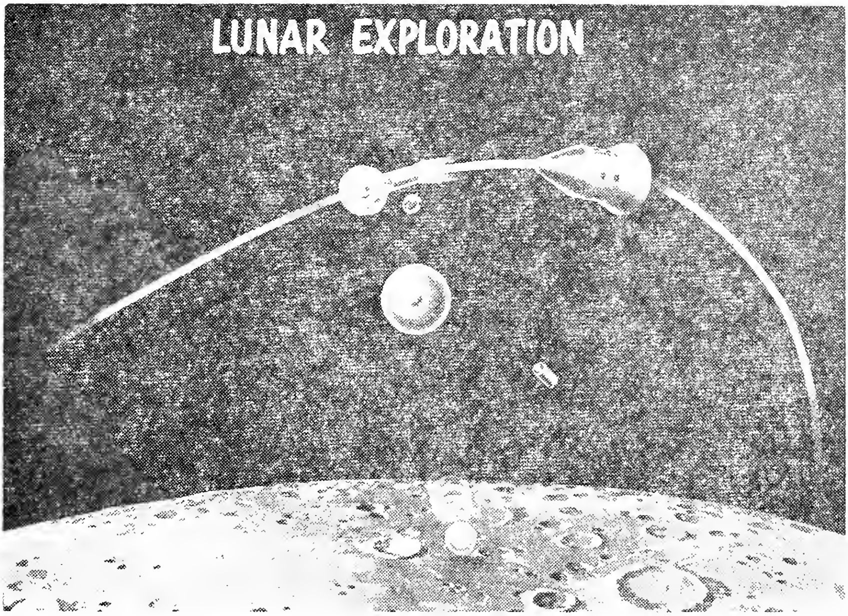

FIGURE 117

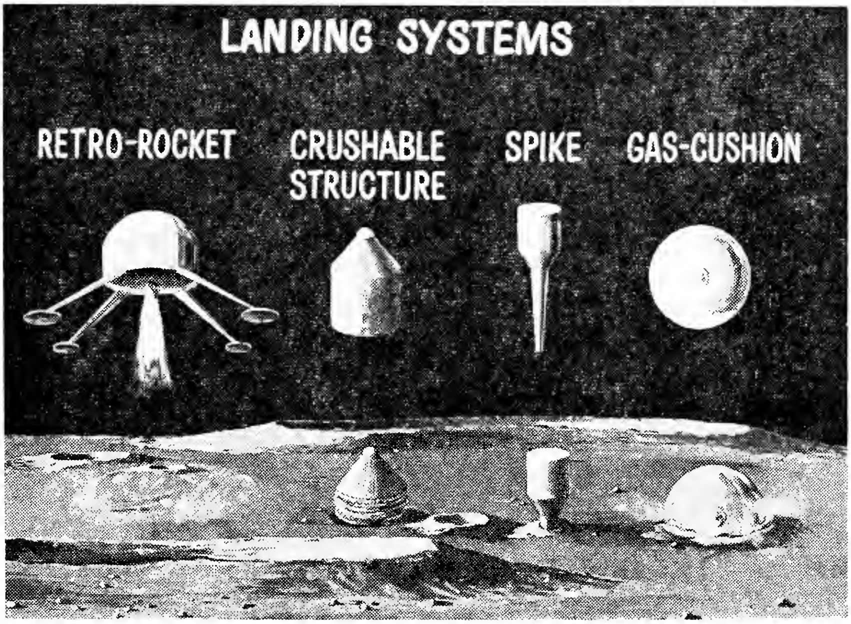

FIGURE 118

in which this can be done. You are all familiar, I am sure, with proposals that have been made to lower a suitable container to the lunar surface by means of retrorockets, such as indicated at the left on this chart. This kind of system permits a soft or easy landing, even in the absence of a lunar atmosphere, and is the kind of system that will have to be used to place a man or men safely on the Moon. However, it is complex and heavy. The research problems involved are common to other aspects of space flight—viz: lightweight structures, stabilization and control, guidance, throttleable rockets, et cetera.

Because of the complexity of the soft-landing system, we seek simple ways to land instrument packages on the Moon. Instruments can be made rugged enough to withstand impact accelerations higher than those suitable for man. Consequently, we can consider systems that land at rather high speeds, and therefore, do not require all of the guidance, control, and fuel required of a soft-landing system. These simpler systems do, however, require means for absorbing the shock of impact.

Some of the means to which I allude are now being investigated and are indicated on the chart. They are crushable structure, penetration spikes, and pneumatic cushions. Of course, in studying these systems, we must at the moment assume that the hardness of the lunar surface is comparable to that of the Earth's surface. We are, however, developing techniques for measuring the hardness of the lunar surface, so that when we send a rocket to the Moon we will be able to obtain this essential information. Meanwhile, studies of the energy-absorbing schemes are proceeding.

The crushable-structure concept employs lightweight metal structure, such as this honeycomb sample that I have here. This piece of material weighs about 2 ounces and it has a capability of absorbing about 600 foot-pounds of energy, which would be somewhere in the neighborhood of a 50-pound mass striking at a speed of 30 feet per second. After it does its job it looks like this, and in the interim it has absorbed energy by deformation of the material.

The penetration spike is a very simple device, but it works only when the surface of the ground is neither too hard nor too soft. It absorbs energy by displacing and compressing the material into which it penetrates, just as a nail absorbs the energy of a hammer blow. Both the crushable structure and spike concepts require proper orientation with respect to the impacted surface. The gas cushion, however, does not have this limitation. It is therefore, the simplest of all systems although requiring more research to understand how to design it. In the case of the gas cushion, the instrument package is suspended in the center by numerous radial cords, which, unfortunately, are very difficult to see in that sketch.

The system falls freely in the lunar gravity field because there is no atmosphere. Upon impact the cushion compresses until the instrument package is brought to rest on the impacted surface. At this instant, the bag is split to avoid rebound. Energy is absorbed by compression of the gas, by shock waves generated in the gas, and by distortion of the bag skin. Gas cushions suitable for landing instrument packages on the moon might range between 5 and 25 feet or more in diameter, depending on the orbital height and the size and weight of the instrument package.

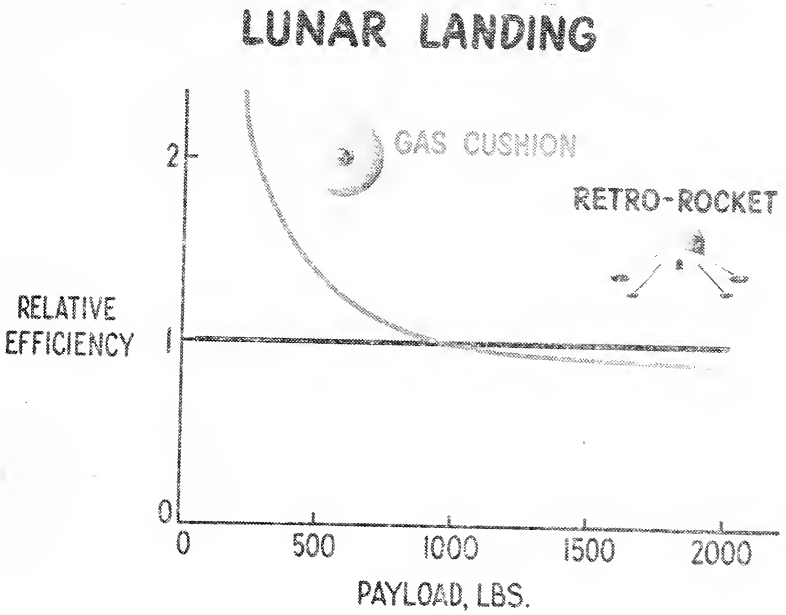

FIGURE 119

Because of the attractive simplicity of the gas cushion, it is undergoing extensive investigation in our research centers. The next chart shows how its efficiency compares with that of the soft-landing retrorocket system (fig. 119). Here, the efficiency of the gas cushion relative to the retrorocket system is shown plotted against payload weight. By payload here we now mean only the instrument package carried by either landing system. In both cases the necessary auxiliary control and guidance systems have been taken into account. As you can see, the gas cushion is superior to the soft-landing retrorocket system at the smaller payload weights especially in the very small sizes. At the higher payload weights, the choice between the two systems becomes small and the retrorocket becomes superior. Even so, the gas cushion might still be used because of its greater simplicity and reliability.

Now, before we are ready for a manned mission to the Moon we shall, of course, be sending unmanned spacecraft there. I have here a model of a spacecraft intended for lunar exploratory purposes. It is currently under development by the Jet Propulsion Laboratory. This spacecraft will weigh about 700 pounds and is intended to be launched in 1961, I think, for the first time by the Atlas Agena-B. The two folding vanes are solar energy collectors. The dish-type antenna, here, is intended to transmit and receive signals to and from the earth. The main body of this spacecraft contains attitude control and navigation equipment, instruments, radio, et cetera. At the top is a capsule which in due course of time will become detached from the vehicle and make a semisoft landing on the Moon. This is the retrorocket and these are penetration spikes. The main space craft

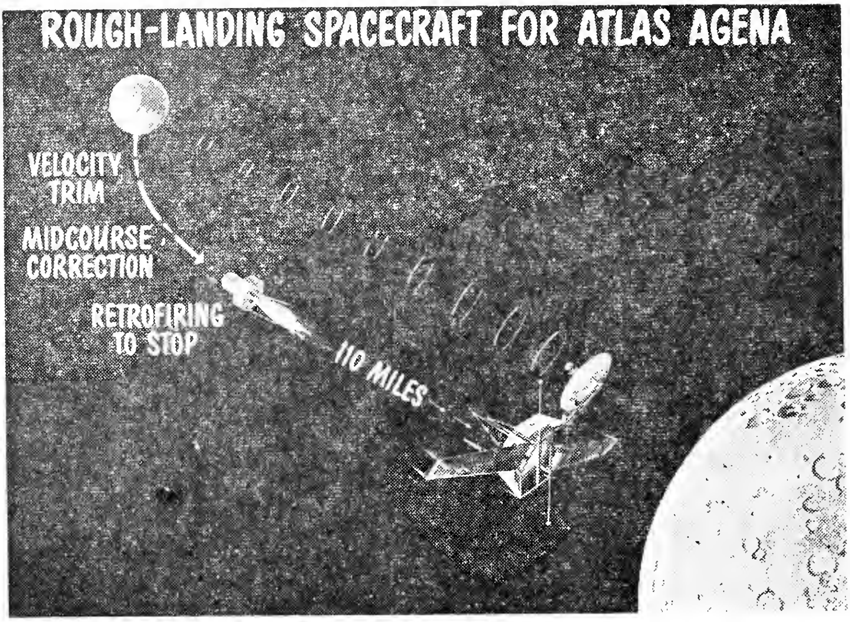

FIGURE 120

will crash. Now, we have a chart (fig. 120) on this, too, which shows the sequence of events. During the early phases of the flight, as you will see from the chart, there has to be injection guidance and midcourse guidance exerted to put the thing on its way, and when it gets to about 110 miles from the lunar surface the retrorockets fire in order to stop the motion of the capsule. The main spacecraft, as I said, goes on its way and just crashes and is destroyed on the lunar surface. The small capsule, of course, finally lands on the Moon, its impact energy is absorbed by the penetration spikes and it goes into operation obtaining data and transmitting them by radio back to the Earth.

For truly soft landings on the Moon we must wait for the larger rockets such as Saturn. Soft landing systems for both of these vehicles are under study. I have some models of those that are under study. In case any of you might be interested in them later I will describe them, but as they are just in the study or imagination stage at the present time, I shall not describe them as I have the Agena spacecraft which is currently under development and actually funded.

The final phase of a manned lunar circumnavigation mission is return to Earth, reentry (fig. 121) into the Earth's atmosphere and landing. The space-flight problems on the return trip are no different from those on the outbound trip, with the possible exception that navigational accuracy is more critical. The problem of reentry is, however, peculiar to this phase and is a very serious one. As you know by now, there are two basic schemes for accomplishing reentry: (1) The ballistic method with a nonlifting capsule, and (2) the winged or lifting method.

Both of these methods have advantages and disadvantages. The ballistic capsule is much simpler than the lifting system and is there-

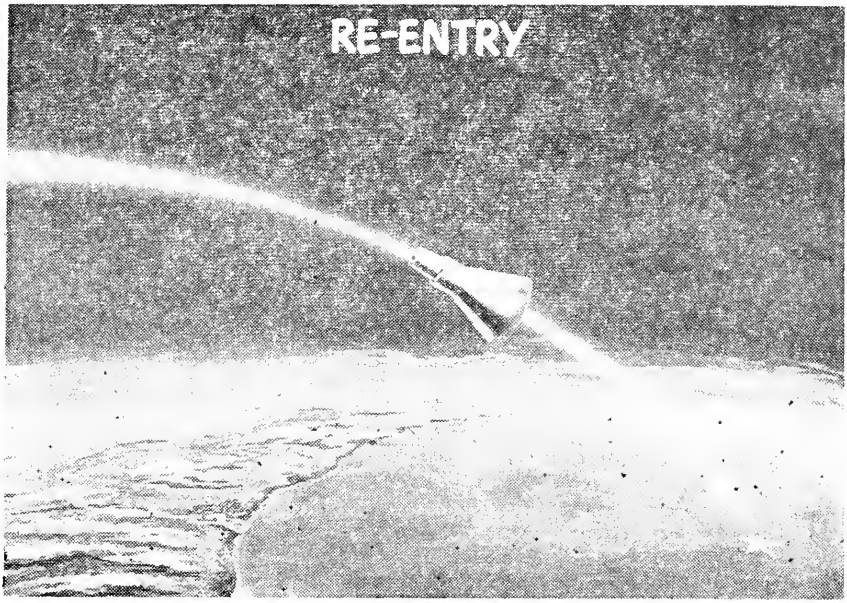

FIGURE 121

fore suitable for a first step such as Project Mercury. It has the disadvantage, however, of imposing very high g. loads when reentering at higher-than-earth orbiting speeds; it also lacks operational flexibility and requires a large landing area such as the Atlantic Ocean and an extensive retrieval operation. For these reasons, lifting capsule and winged reentry vehicles are under study.

The lifting vehicle, which overcomes the disadvantages of the ballistic capsule, is more complex and is subject to higher heat loads and temperatures. Here is a photograph (fig. 122, p. 676) of a lifting vehicle structure under test at our Langley Research Center. The structure is the triangular object in the middle. The beams at the lower part of the photograph are loading devices for imposing the structural loads on the structure and the heating device is the battery of very hot lamps shown at the top, lifted out of position. Normally, during the test that battery of lamps comes down in close proximity to the skin of the model.

The next chart gives an idea of where we stand today with respect to our ability to develop and build winged reentry vehicles. This current ability has been made possible by our past research investigations, such as that indicated by the photograph shown a moment ago.

The chart (fig. 123, p. 677) shows temperature in °F. plotted against a time scale of calendar years. The upper curve labeled "Reentry temperature" shows, by its downward trend, as it moves toward the right, how the state of the art in aerodynamics, as related to the heating problem, has improved over the past few years. It represents the structural temperatures that would have been obtained during reentry at satellite speed with the best aerodynamic configurations we knew how to build at the different periods of time. With the X-15 configuration in

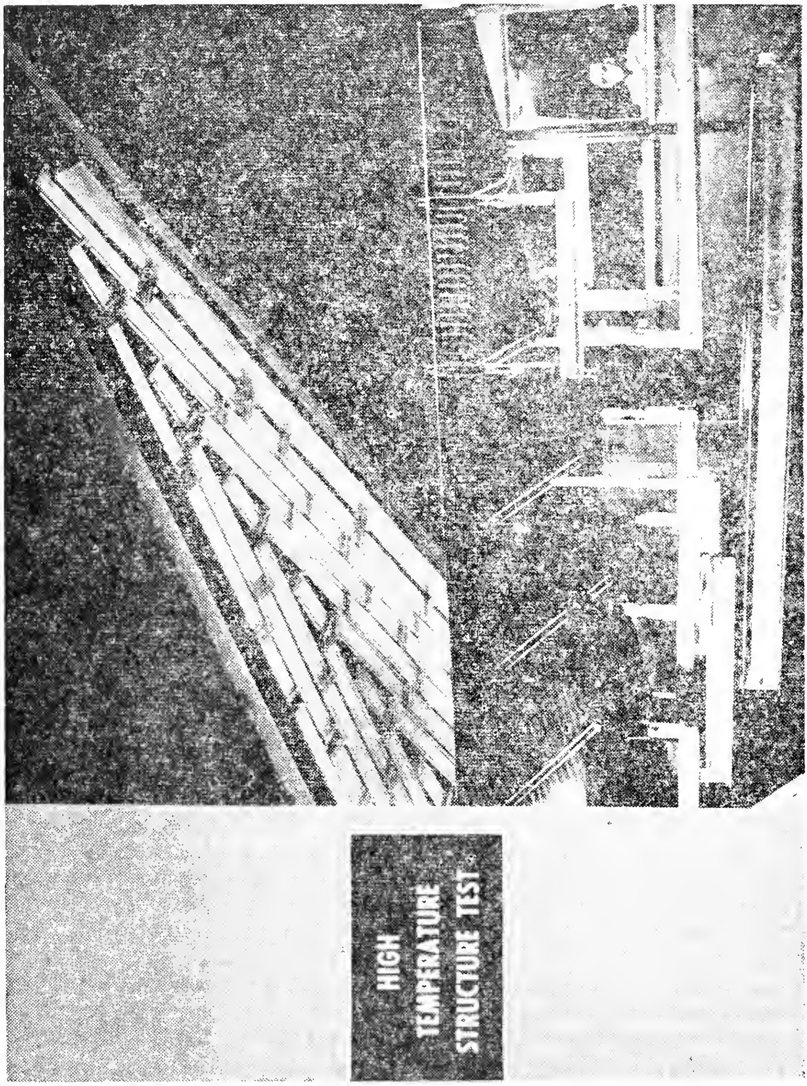

FIGURE 122

1955, for example, the temperature of the structure during reentry at satellite speed would have been something over 5,000° F. As time and research progressed, we learned how to reduce the heat load, and therefore, the structural temperatures, by changes in the aerodynamic configuration. Sharply swept-back arrow-shaped wings, blunt leading edges and operation at high angles of attack were the key aerodynamic features resulting in the reduced temperatures indicated on this chart.

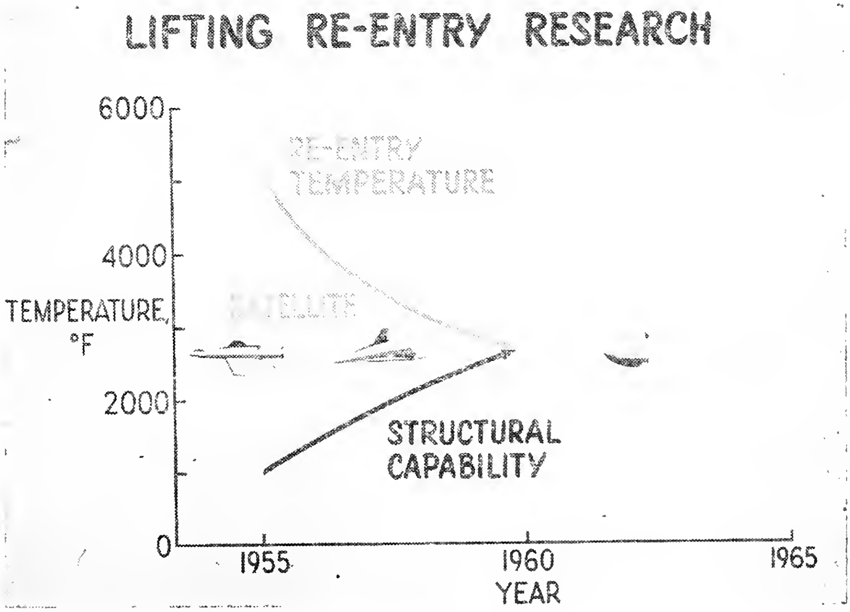

FIGURE 123

In a similar way, the lower curve shows by its rising trend how the state of the art in structures and materials has improved. This curve represents the temperatures that could have been withstood by structures that we could have built at each period of time shown on the chart. The X-15 structure, which we knew how to build in 1955, can withstand a temperature somewhat greater than 1,000° F. as shown at the left end of the lower curve. Obviously, the wide gap between the two curves in 1955 indicates that we were not ready then to build winged vehicles for reentry at satellite speed. The X-15 is not that fast.

A short time ago the two curves came together, so that now the development of a winged or lifting vehicle for reentry from satellite speeds is just barely possible. We have in essence a crude solution to this problem which makes possible the construction of a flight research type of vehicle such as Dyna-Soar or the lifting capsule, such as you will hear later about from Mr. Low.

Our lunar mission will require considerably more research, as the curves on this next chart indicate. Reentry from a lunar mission is made at substantially greater than satellite speed and the heat loads are, therefore, much higher. Unfortunately, it does not appear at

present that the reduction in heat input resulting from improvements in aerodynamic shape will continue at the same rate as in the past. We must, therefore, look primarily to improvements in structure and materials to solve this problem at some indefinite time in the future.

Some progress is being made in this area, for example, with molybdenum. Molybdenum, or moly, as we say, because it is much easier to say, has a high melting point and is attractive for high-temperature structural applications, provided that we can learn how to weld it or otherwise fabricate it and also keep it from burning up at the high flight temperatures. This requires application of heat and oxidation resistant coatings compatible with the underlying moly. Although some progress has been made here, the final solution has not yet been achieved.

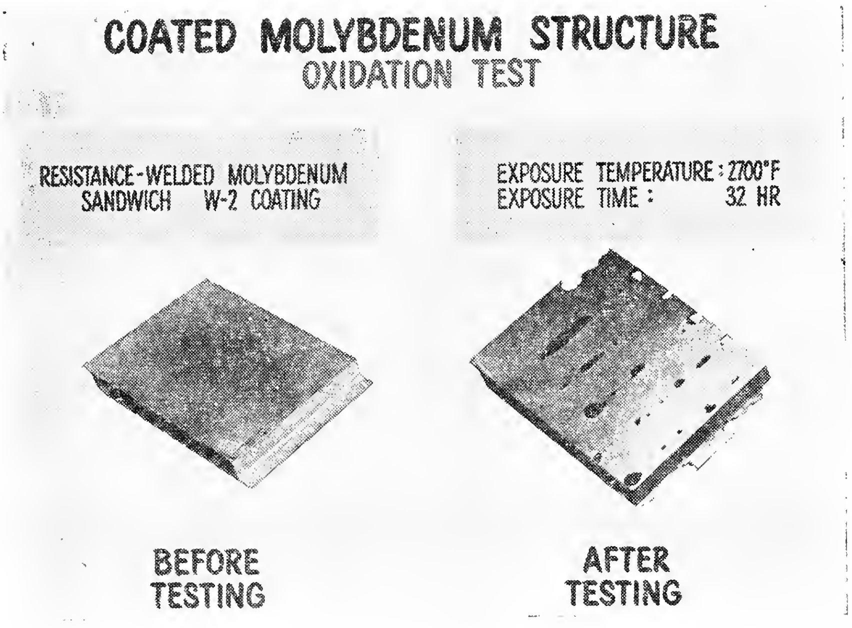

FIGURE 124

This next chart (fig. 124) shows two structural "sandwich" specimens made of molybdenum sheet and coated with a commercially available product. The fact that these specimens were made at all indicates that progress has been made in learning how to fabricate the material. Our laboratory people are quite proud of that specimen that you see at the left for this reason—incidentally, I have that specimen here in my hand if you would care to examine it.

The specimen on the left has not been tested. The one on the right has been subjected to a temperature of 2,700° F. in air. Note that on this heated sample the coating has remained intact except near the welds, so it is fairly obvious, I think, that we have something more to learn about how to keep these things from burning up, before we would wish to put men in a winged reentry vehicle from a lunar mission.

To conclude, gentlemen, I have tried to show you something of our advanced spacecraft research and technology and its meaning. This activity covers a wide variety of problems relating to launch and exit, space flight, lunar and planetary exploration and reentry into the earth's atmosphere. Current developments are pushing the present state of the art, but we are confident that our research activity will point the way toward safe, reliable and reasonably economical space flight.

Thank you.

The CHAIRMAN. Thank you very much, Mr. Rhode. Now, we have Maj. Victor W. Hammond, Air Force, tracking and data acquisition program, from NASA.

STATEMENT OF MAJ. VICTOR HAMMOND, TECHNICAL ASSISTANT TO ASSISTANT DIRECTOR OF SPACE FLIGHT OPERATIONS, NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

Mr. HORNER. Mr. Chairman, Major Hammond does not have a prepared statement. He is going to talk with the assistance of some charts here at the right.

The CHAIRMAN. All right. He can proceed as he wishes to before the committee.

Mr. HECHLER. Was the witness sworn?

The CHAIRMAN. This is not a part of the other hearing.

Major HAMMOND. Mr. Chairman and members of the committee, you have heard a good deal during the NASA testimony relating to space vehicles, trips to the planets, various satellite missions, application satellites and tomorrow you will hear Mr. Low on the manned space flight program, Mercury.

However, without ground support instrumentation, in other words, the instruments that track and derive data from these various endeavors into the exploration of space, these missions that you heard so much about simply could not be accomplished.

My subject then is ground support instrumentation. I plan to give you a bit of background, to begin with, so that we will all be talking in the same language.

Secondly, I will give you a short operational example of one of our tracking systems, namely the minitrack system in actual operation, and thirdly, a progress and planning report on our various tracking and data acquisition networks.

First of all, those of us in the instrumentation business are confronted with four basic missions: The vertical probe, the satellite, and by this I mean the Earth satellite class of vehicle, the manned satellite, namely the Mercury, and the deep space probes (fig. 125, p. 680).

Now, these missions manifest themselves as problems in the way that we have to set up instruments to collect data from the various different types of missions.

First the vertical probe. The majority of these type of NASA missions are launched from Wallops Island, on the coast of Virginia. This is essentially an up and down type of trajectory, and therefore, we group our instruments around the base of the launcher and simply derive the information as the vehicle flies, recording it for later analysis. There is no hurry about analyzing the data since this is

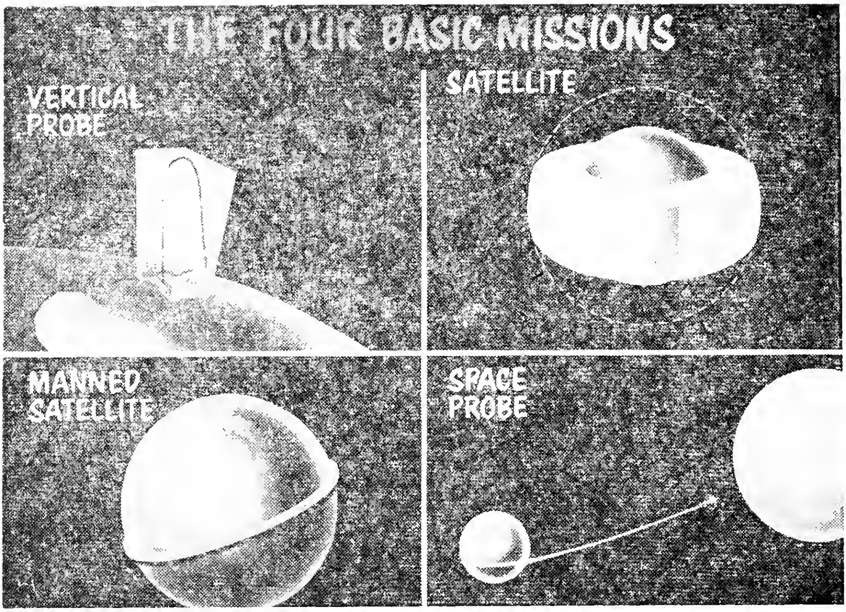

FIGURE 125

essentially a one-shot mission, it goes up and comes back. This is not so with the satellite.

The satellite, as it flies in its orbit around the Earth, its movements, plus the Earth's movements, create the effect that the satellite over a period of time and by time, I mean weeks, months and years, creates the effect that that satellite is flying and actually configuring a large band around the Earth.

Now, if we follow the same philosophy as with the vertical probe, one would think that we must keep the satellite under surveillance at all times. This is not so. We only take routine observations as it passes a single segment.

You will find, when I get to the minitrack network (fig. 126) on a map, that the instruments, themselves, are essentially deployed in a line. This allows us to have adequate contacts with the satellite, yet have only what we could call, an economical number of stations to actually do the job.

This type of data is classed as nonperishable, since there is no hurry to collect it and process it.

Now, this is quite different in the case of the manned satellite. The manned satellite, of course, will only be up its entire mission—the entire mission of Mercury must be successfully completed in about 4½ to 5 hours. Therefore, that data is quite perishable. The data must be taken, sent back to computers, and processed in real time. Now the term "real time" simply means as it is occurring.

Now the space probe, of course, is characterized by extremely long distance data links, hundreds of thousands of miles. This is why you will then see the space probe instrumentation consisting of such huge antennas as you see here in the model.


MINITRACK NETWORK
PRESENT FACILITIES
BLOSSOM POINT, MARYLAND
FORT MYERS, FLA.
SAN DIEGO, CALIF.
ANTIGUA, W. I. F.
QUITO, ECUADOR
LIMA, PERU
ANTOFAGASTA, CHILE
SANTIAGO, CHILE
WOOMERA, AUSTRALIA
PLANNED FACILITIES
ST. JOHN'S, NEWFOUNDLAND
FAIRBANKS, ALASKA
E. GRAND FORKS, MINNESOTA
SOUTHERN ENGLAND

FIGURE 126

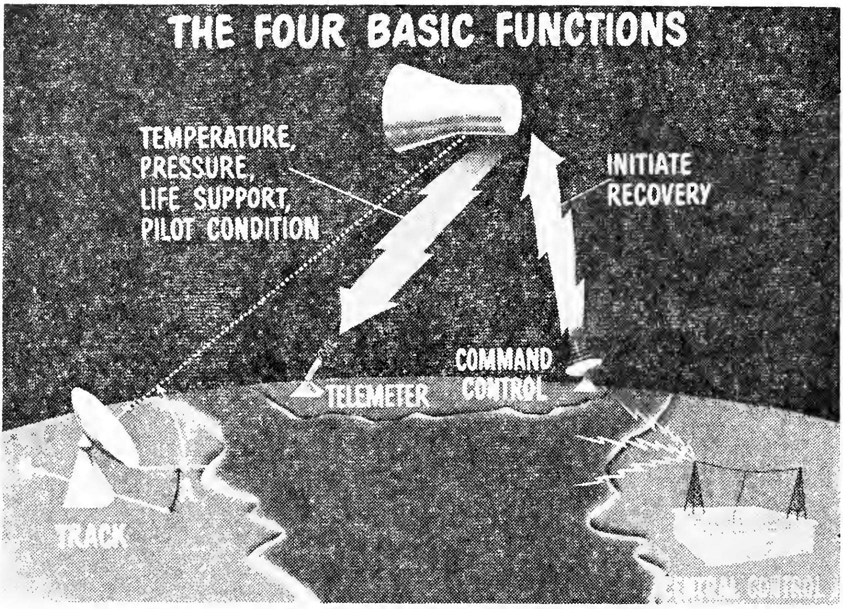

FIGURE 127

Now, on each one of these missions there are four things to be done (fig. 127). They are done differently in each case. First of all we must know where the vehicle is in space. This is the function of tracking.

Secondly, we must know what is going on inside of the vehicle. This is the function of telemetering. This is the device that reads the various physical perameters. The soundings that the scientific instruments are taking while they are actually in orbit or during a probe trajectory.

Third, it becomes necessary to give instructions to the vehicle. This is known as command control. And in the case shown in the chart here, for example, to initiate recovery we would command this to be done from the ground command control transmitters.

Now then, these three functions are tied together in the integrating element of central control. This is where now the data as it is taken, is sent to the central control, processed in computers and the entire net, the administrative tie-together, the entire integration of this into an operable network, is then—this function takes place in the central control.

Now, I would like to give you a very short example here of the times that were involved in Vanguard III that was launched last September. To do that, I will use a map showing the minitrack network. There is one technicality here. You will see I refer to a station at Grand Turk Island, which is down in the Atlantic Missile Range. That you will not—you will not see a mark on the map for that station since it has been deactivated at the completion of the Vanguard program.

The vehicle was launched at an arbitrary time "T", and the Grand Turk location received certain readings at plus 3 minutes. This infor-

OPERATIONAL EXAMPLE

(MINITRACK TRACKING OF VANGUARD III, 1959 ETA)

TIME "T" (0520Z)	LIFT-OFF	T+1HR 27MIN	ANTIGUA MEASURED DATA
T+3MIN	GRAND TURK, QUICK LOOK	T+2HR 15MIN	SAN DIEGO, QUICK LOOK
T+5MIN	ANTIGUA, QUICK LOOK	T+2HR 25MIN	QUITO, QUICK LOOK
T+47MIN	JOHANNESBURG, QUICK LOOK	T+3HR 5MIN	JOHANNESBURG, (2nd PASS)
T+1HR 18MIN	GRAND TURK, MEASURED DATA	T+4HR 40MIN	QUITO & LIMA, (2nd PASS)
T+1HR 22MIN	WOOMERA, QUICK LOOK	T+8HR 50MIN (1410Z)	CONTROL CENTER ISSUES FIRST ELEMENTS

FIGURE 128

mation was sent back to central control here in Washington. Now the same information takes place at Antigua Island, 2 minutes later. Antigua is this location right here [indicating fig. 128].

This quick-look information—I want to differentiate between quick-look and measured data that you will see coming up later. The station personnel are only confirming that the satellite did, in fact, come into their sphere of tracking. This information coupled with precomputed information prior to launch, gives some early feel for whether the satellite is going into orbit. The personnel at these two stations now proceed to take their recorded information and derive the actual measured data from it. They will be transmitting it back in about 1 hour, 18 minutes from Grand Turk and 1 hour, 27 minutes, in other words, 1 hour and a quarter to read the data and get it back. This shows the lack of hurry in this type of operation. The satellite proceeds on by Johannesburg, +47 minutes, over Woomera, an hour and 22 minutes, San Diego, 2 hours and 15 minutes. By this time the central control station here in Washington has sufficient information for it to know: Yes, we did achieve an orbit. However, as far as being able to accurately describe this orbit, mathematically, this is as yet impossible. The satellite proceeds on its way and the information continues to be taken as it passes over the subsequent stations.

Let's now jump to T plus 8 hours, 50 minutes. This is the first time with Vanguard III that the control center is able accurately to describe the orbit. This is quite satisfactory for the routine satellite mission as I defined it earlier.

However, note how completely unacceptable this would be for the manned space flight which must be completed in 4½ to 5 hours.

This now shows you a very important difference in the engineering approaches to the satellite instrumentation as opposed to that of the manned space flight. This is one of the reasons why you will see the vast difference in instrumentation of these two types of missions.

Now, with regard to the progress and planning, first the satellite tracking (fig. 129): We track satellites, the Earth satellite vehicle, with essentially three methods.

First, the minitrack system which must have an active transmitter in the satellite.

Secondly, we use the Baker-Nunn cameras, which I will cover again in just a moment. This, of course, can track any type of satellite as long as the camera is told where to look.

FIGURE 129

Thirdly, we use the Moon-watch teams. Again, they can track any satellite as long as they are told where to look. These again are very basic differences.

Now, as of next October we will have some 14 minitrack stations capable of tracking and receiving telemetering on not only the currently used frequency of 108 megacycles, but also on a new internationally assigned frequency of 136 megacycles.

Now, the reason I mention this frequency change is because we were—not only for technical reasons, but also because of radio frequency interference problems—were forced to go to the 136-megacycle frequency.

Now, changing frequency at a minitrack station is not quite as easy as tuning a radio receiver as one would do in their home. This is a one-fortieth scale model of a minitrack antenna [indicating]. There are some eight of these at each one of these stations. These

form the interferometer baseline that is used. These antenna elements are precisely cut units, they must be cut to the proper size to receive on the optimum frequency that they are designed for.

Obviously changing frequency means changing antennas, plus the electronics that derives the tracking data from the antenna.

Now, in the original IGY, International Geophysical Year, minitrack equipment, the antennas were oriented so their antenna pattern was oriented north and south. This means that on the low inclination orbits they cut through this pattern quite nicely.

However, on a high inclination orbit, such as the polar orbit, you will note that the orbit could come essentially parallel with the beam; and the tracking, of course, would not be accomplished.

Therefore, in October, as I mentioned, our stations will also be equipped with an east-west beam that will allow this network to be able to track any satellite, providing, as I pointed out, it carries the proper type of transmitter.

Our station operators, as I pointed out in the operational example—currently have to actually read the measured data from the records. This gives rise to human errors at times. We are installing automatic translation equipment so that this will not be necessary.

Now, the Baker-Nunn locations. The Baker-Nunn camera, incidentally, is an especially designed ballistic type camera that uses a film. We have 12 of these located, as you see on the map (fig. 130, p. 686). They are limited, in that the camera must be in the dark of the Earth, while the satellite is illuminated by the Sun. This gives what is known as a good optical signal-to-noise ratio. In other words, the ambient light is not causing any fogging of the tracking camera film.

We continue to take routine observations with the Baker-Nunn network and the Moon watch teams which are, incidentally—this work is done for NASA by the Smithsonian Astrophysical Observatory on a grant.

We will augment our optical capabilities somewhat in the future for the geodetic satellite program, but currently our activities in optics are essentially to look at this limitation that I pointed out here, hopefully to give us a greater range of use of these cameras.

The data taken from these cameras, incidentally, is about 40 times more accurate than the information taken from minitrack equipment. And this is basically why it is used. This gives the finest tracking information that we have available to us.

Now, the Mercury program. You will hear the details of the Mercury program, itself, tomorrow from Mr. Low. However, from the instrumentation point of view, I would like to give you a few comments with regard to the problems that it means to the instrumentation engineer.

First of all, since there is human life involved, reliability is, of course, a very prime thing. The data, as I pointed out, is perishable, it must be handled in real time. We do not have the time, as we do with the minitrack, to essentially bootstrap ourselves into a position of accuracy. The accuracy has to be inherent in the early tracking. You will note here on the chart (fig. 131, p. 687) now that the Cape Canaveral radars have tracked the vehicle into its orbit and after about 3 minutes the Bermuda station is able to track for some 5 minutes. This tracking information is sent back to the central control where it is

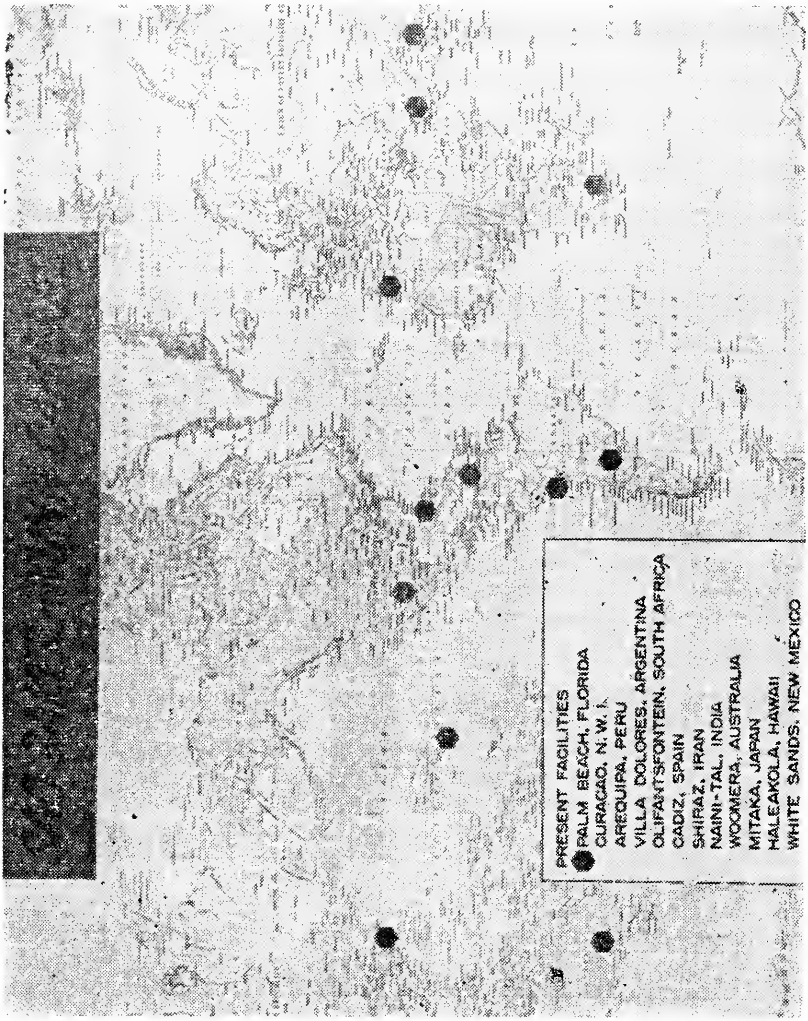
PRESENT FACILITIES
PALM BEACH, FLORIDA
CURACAO, N.W.I.
AREQUIPA, PERU
VILLA DOLORES, ARGENTINA
OLIFANTSFONTEIN, SOUTH AFRICA
CADIZ, SPAIN
SHIRAZ, IRAN
NAINI-TAL, INDIA
WOOMERA, AUSTRALIA
MITAKA, JAPAN
HALEAKOLA, HAWAII
WHITE SANDS, NEW MEXICO

FIGURE 130

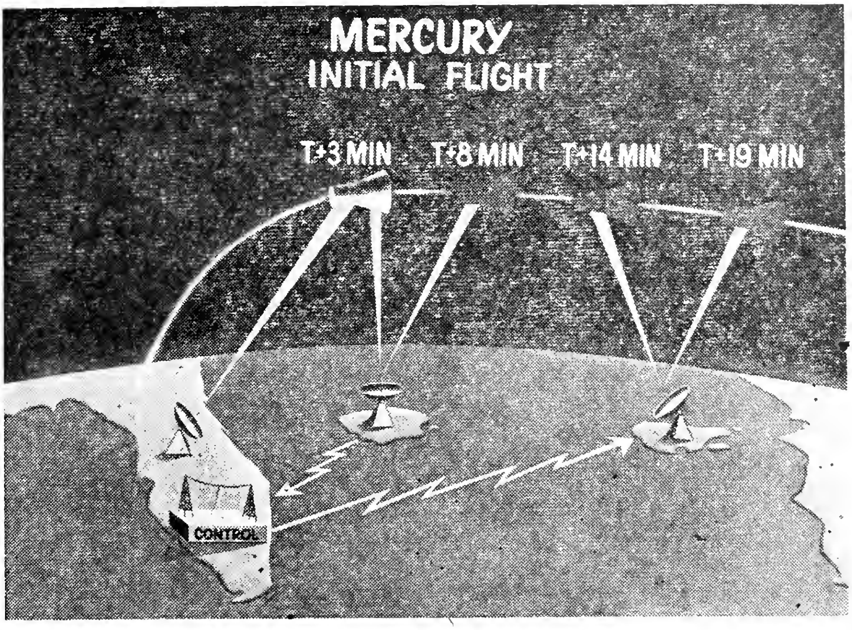

FIGURE 131

processed, the orbit is constructed and look angles, or, in other words, from the information that the computers derive from this tracking data they are now able to tell the Canary Island station, the next station along the trajectory where it must look to pick up the satellite as it comes within its view.

You will note there is a period of time over the Atlantic Ocean and where that capsule will not be under track, a period of some 6 minutes here.

This, however, although it is not tracked, there is a station in the mid-Atlantic, a ship that communicates with the capsule and receives telemetering information.

The total Mercury network is as you see it on the chart (fig. 132, p. 688) here, some 18 stations.

The Mercury network consists of various available military equipment that was already available on the national ranges, and also some Australian capability, plus several stations that have been put in by NASA specifically for this purpose.

Now, we have the Mercury launched. Let us recover it. We have the same problem exactly in reverse. That is, timely handling of the data. The station in Texas has performed its last tracking function, the station at Eglin Air Force Base, Cape Canaveral, and Bermuda, are all tracking and sending their information to the central control that is now predicting where the impact will be, and leading the recovery forces into the actual impact area.

The Department of Defense, in conjunction with the NASA, is putting together this network. It will be operational early next year. I would like to show you a model of two of the stations. I want to

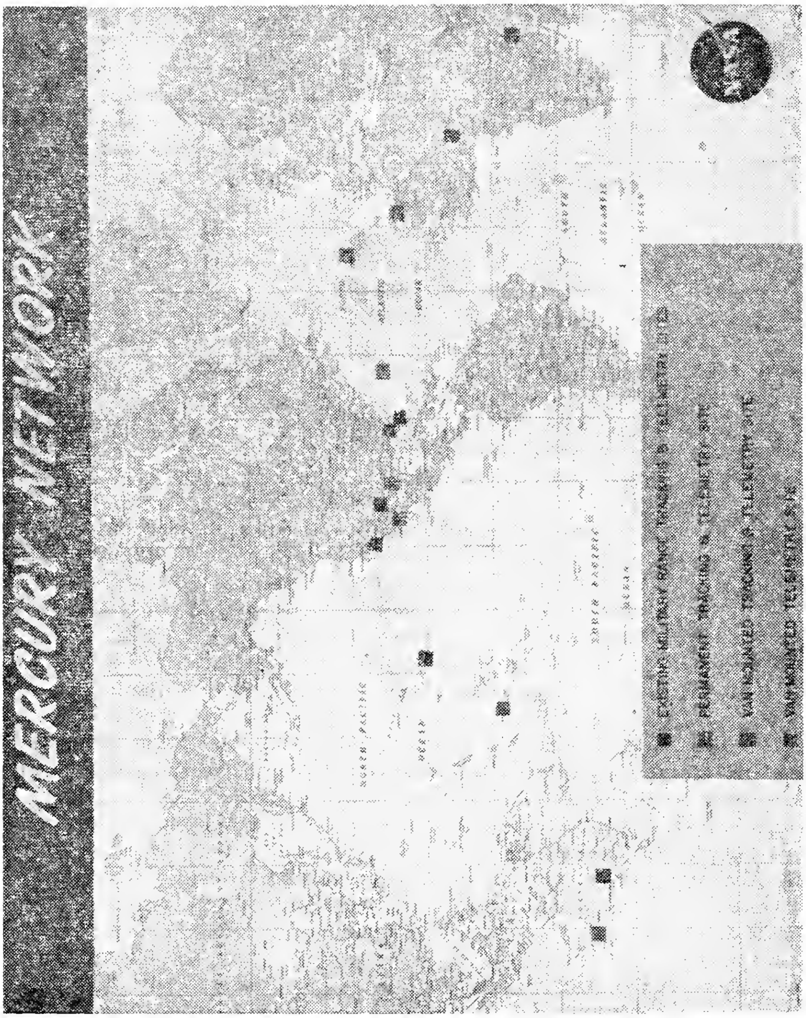

FIGURE 132

show you Kano, Nigeria, which is one of the simplest stations, and Bermuda, which is one of the, perhaps, most complex.

Perhaps if you lifted it up, gentlemen.

Now, this is Bermuda on this side [indicating]. You will note that the receiving equipment and the transmitting equipment are separated. You look at the general map of Bermuda, they are separated by several miles.

The C-band radar (an FPS–16), the S-band radar here (fig. 133), the transmitters to talk to the pilot, the command transmitters to control the activities of the capsule, itself. The equipment to, again, communicate with the pilot and to receive telemetering information [indicating].

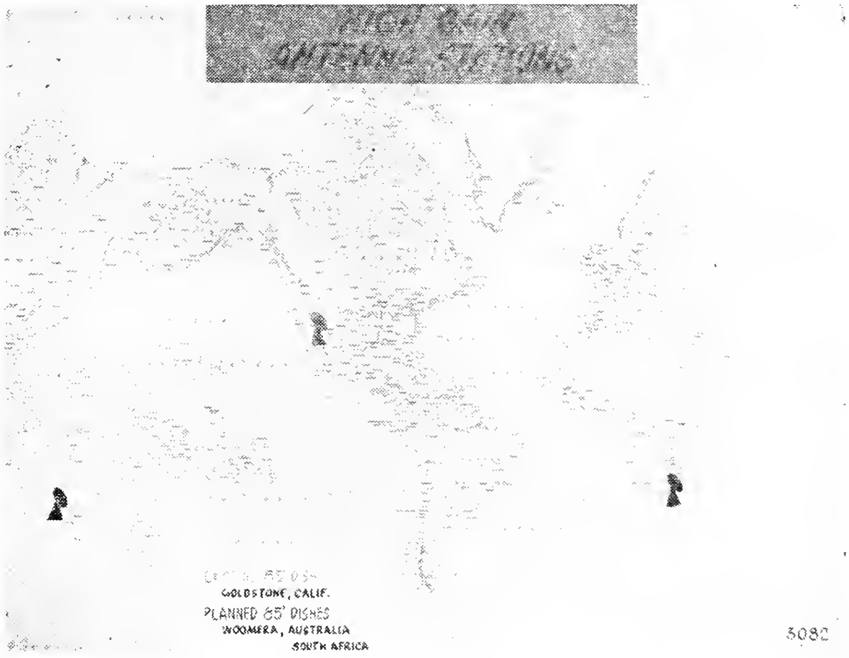

FIGURE 133

Now, on Kano, there is no tracking function taking place, only that of transmitting and receiving voice communications with the pilot and receiving telemetering information. This station, incidentally, is one of the anchor points of the ground communication links of the entire network that I will mention in a moment when I get to communications.

Now, in the design of the Mercury network, two things were held paramount. First of all, we attempted to use all existing instrumentation that was applicable.

Second, we have used a temporary-movable concept wherever possible with the idea being that the stations can be relocated at the completion of the Mercury program (fig. 134, p. 690).

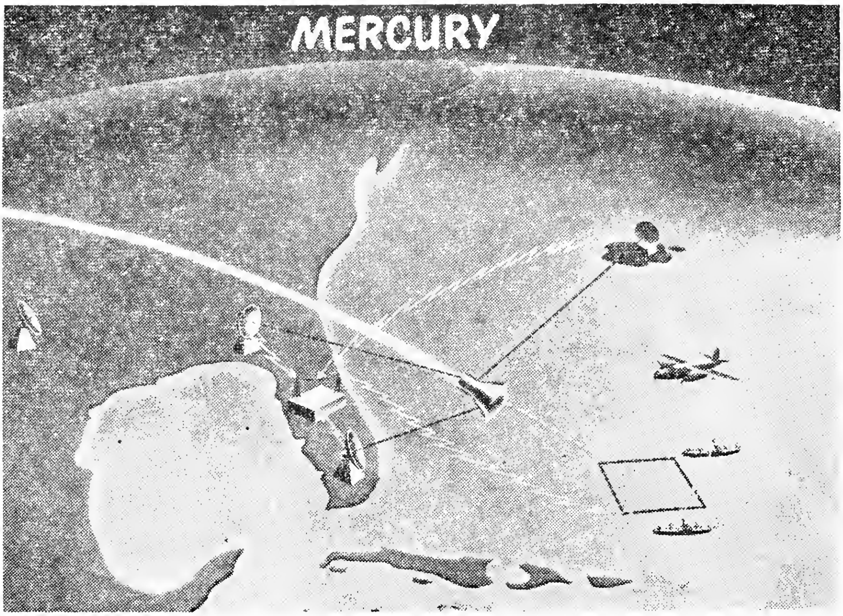

FIGURE 134

Now, upon completion early next year, the net will have a telemetering and tracking coverage on a 33 degree orbit, originating at Cape Canaveral for a maximum of some three orbits.

We have a complex of three stations that over the next number of years will figure very highly in the exploration of space and will be the instruments that will receive signals from the various devices that are placed upon the Moon's surface and upon the surface of the planets as well as from the probes themselves. This is the deep space net (fig. 135).

The problem here, now, of course, again as I pointed out, is that of the extremely long distance data links. There are many hundreds of thousands of miles that the signal must travel. The transmitters, particularly at this time period, must be kept small because the propulsion available is small. The transmitters available, that is the power available in the vehicle, is necessarily small because of the weight. And, of course, that is not at all in keeping with the distances that the signals must travel. We also have a problem of linking these three stations together. Where we had to link the stations together rapidly in the case of Mercury, and then with not such a rapid time phasing, with the routine satellite, it turns out that with the deep space probe you have to go from fast to slow to fast. I will explain what I mean by that.

This is perhaps best explained by the operation of the network (fig. 136). This is a view of the earth from the South Pole.

Now, at launch—I had better explain this chart a bit further. This is a view of the earth from the South Pole, this is South America here, Africa and Australia. This will be the station at Goldstone, Calif., and the station here at Australia, and this one in South Africa.

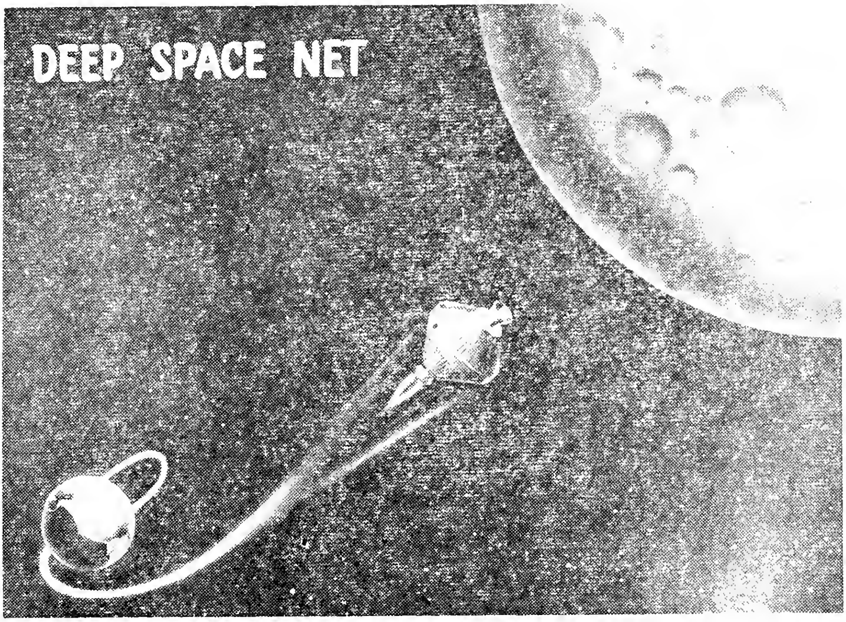

FIGURE 135

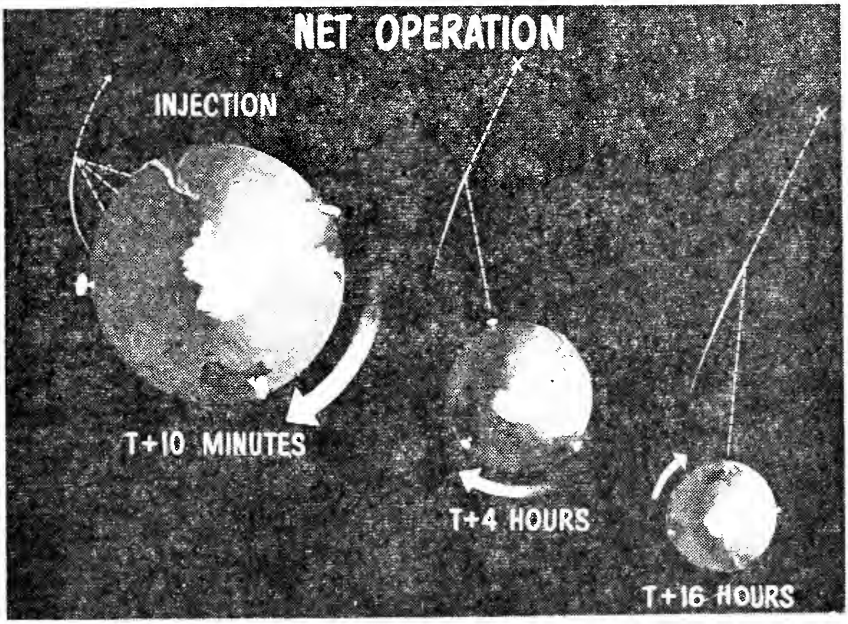

FIGURE 136

Now, at launch from, say, the Atlantic Missile Range, the AMR instrumentation derives the position and velocity data or the injection data from the vehicle and sends this to the control point that then computes and predicts in advance where the vehicle will be in some 4 hours when the earth has rotated and the Goldstone, Calif., station is now in a position to track the vehicle.

Again, as Goldstone completes its track, it must now send its information to the control point so that the predictions again can be made for Australia to find the target, lock on it, and effect its track.

Now, this is very imporant during these first few hours of flight because this is the time period when the early corrections to the trajectory are made.

However, as you proceed into the midcourse phase, or the many-day phase of flight, the predictions can literally be made days in advance. This is why I said that timeliness of transferring the data then loses its importance.

Now then, as the vehicle approaches its target, the Moon, for example, it now comes under the influences of these other gravitational forces and now we must, again, be able to track rapidly and to make corrections and send command information back to the vehicle to control a landing for example.

I would like to point out the antenna, itself [indicating]. This is a model of the antenna that is located at Goldstone, Calif., and is similar to the one that will be in Australia, and South Africa. It is 85 feet in diameter and you will recall the problem I pointed out about the extremely small power and the long distance. This is partially corrected by the fact that this large collecting surface collects the minute quantities of radio frequency energy, focuses them at this feed point and sends them on down to be amplified and acted upon.

This antenna dish, itself, not only tracks, but it receives telemetering information. However, it cannot effect the command control function that I have mentioned before. To do that, you require a second dish.

We currently have a second dish for the command function at Goldstone. We plan, as requirements exist, to install a second dish in Australia and one in South Africa.

You will recall the explanation I gave here of the net operation. The explanation I gave was one in which the vehicle was launched and injected into its trajectory over an instrumented area. If, however, the type of coast trajectory is used that is available with the Agena vehicle or the Centaur, a more optimum point is usually selected to effect this injection. This means that the vehicle will coast in what is known as a parking orbit until it arrives at its optimum point where a second thrust is given to it.

If this occurs over, say, the Indian Ocean, we do not have a highly instrumented area down there as we do in the Atlantic Missile Range. This means that this injection instrumentation now must be placed in a mobile fashion in these remote locations. This also, we are preparing.

Now, on the subject of central control (fig. 137), the minitrack network will come under immediate operational control of the Goddard Space Flight Center when it is completed this summer. The Moon watch and the Baker-Nunn networks are controlled from the

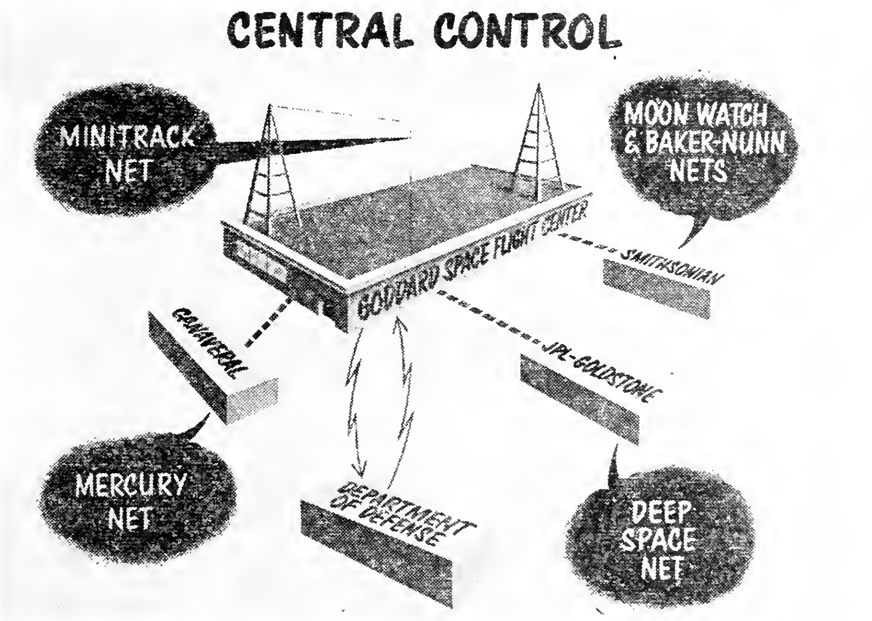

FIGURE 137

Smithsonian, the deep space net at JPL, Pasadena, and the Mercury net through the control point at Canaveral.

Goddard Space Flight Center will be assimilating these control functions as soon as technically and operationally feasible.

Our point of coordination with the Department of Defense will be out of Goddard Space Flight Center to give a single point of contact for our co-use of equipment with the Department of Defense.

Our communication picture is as shown on this chart (fig. 138, p. 694). You can appreciate the value of communications in a farflung network. This is meant only to be a graphical presentation to indicate the farflung nature of these types of instruments that we have out. This looks complex and it is. This is our highest single line item in our instrumentation budget. In 1961, that of communications. We attempt in every case to use either Department of Defense lines that are available or use leased lines, as the case may be. They will all tie into Goddard control center in our final operational networks.

In summary, our major plans for the next fiscal year, that of the vertical probe type of missions is general improvement of the Wallops Island instrumentation, with the satellite missions, the automatic data read out equipment that I mentioned, the new tracking frequency, broad-band special type of equipment and optical equipment for the meteorological and geodetic satellites.

A completion of the manned satellite networks, the Mercury net, and a completion of an initial net receiving capability on the deep space probe.

Now, to complete the picture, our summary for funding is as you see on the chart (fig. 139, p. 695). Construction money, some $31 million, research and development, including the operation of the

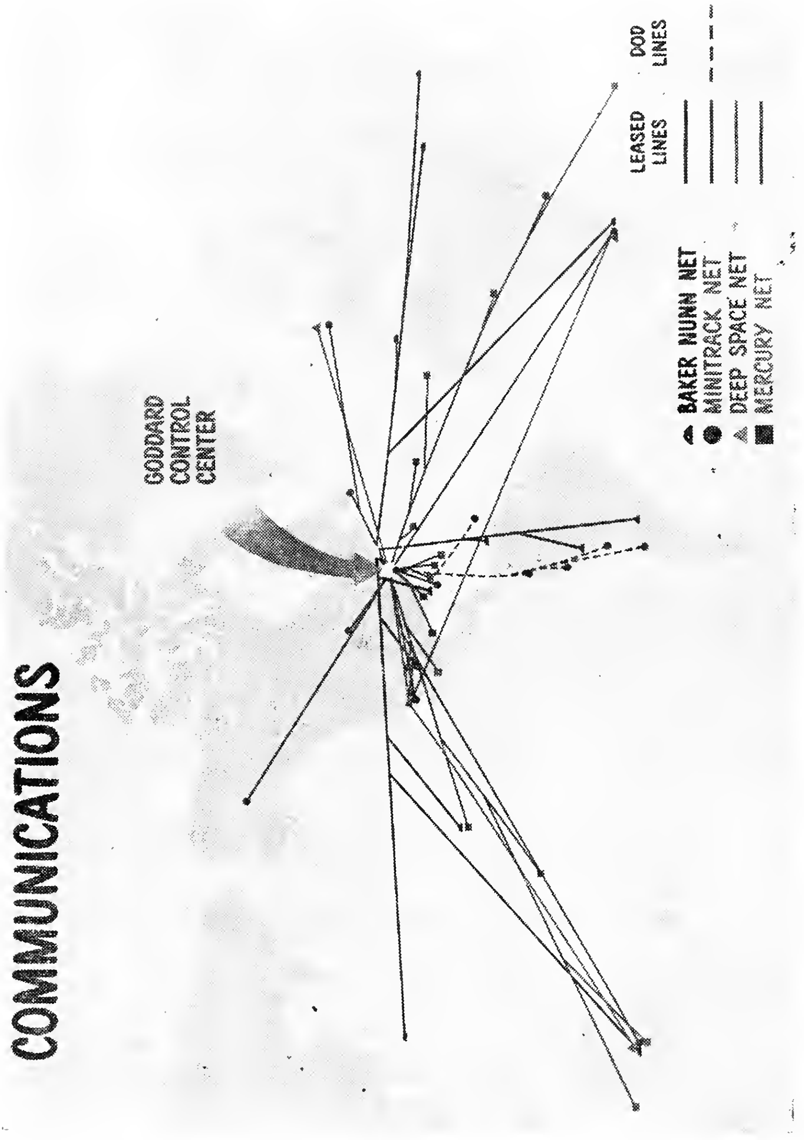
COMMUNICATIONS
GODDARD CONTROL CENTER
BAKER NUNN NET
MINITRACK NET
DEEP SPACE NET
MERCURY NET
LEASED LINES
DOD LINES

FIGURE 138

SUMMARY OF FUNDING FOR FY 61

C & E	(IN MILLIONS)
VERTICAL PROBE	4.00
SATELLITE	4.75
MANNED SATELLITE	15.00
DEEP SPACE PROBE	8.00
TOTAL	$ 31.75
R & D	
OPERATIONS, COMMUNICATIONS & UTILITIES	25.33
ADVANCED TECHNICAL DEVELOPMENT	7.22
TOTAL	$ 32.55
TOTAL	**$ 64.30**

FIGURE 139

networks and the communications, some 32, for a total of 64.3 million in this area of instrumentation.

Thank you.

The CHAIRMAN. Thank you very much, Major Hammond. That completes your statement, sir, and we have already had the statement of Mr. Richard Rhode. Are there any questions now?

Mr. HECHLER. I am pretty low down on the committee. I don't want to jump the gun.

Mr. FULTON. May I just compliment them both on an excellent presentation and thank Mr. Rhode for his longtime interest ever since he was on the National Advisory Committee for Aeronautics.

I spent one conversation with him that was some thousand miles long coming across the Atlantic.

Mr. RHODE. Thank you.

The CHAIRMAN. Mr. Hechler?

Mr. HECHLER. Major Hammond, you have been around this tracking business for quite some time, haven't you?

Major HAMMOND. Yes, sir; I have.

Mr. HECHLER. I didn't quite get clearly whether you have some experience in the Air Force in connection with this?

Major HAMMOND. My experience started out, sir, when I served as executive officer to the Chief of the Flight Determination Laboratory at White Sands Missile Range. This laboratory had the instrumentation at White Sands and the data reduction. After that, I served in the Air Research and Development Command Headquarters in instrumentation research and development. During that time I was Headquarters Project Officer for Project Space-Track.

Mr. HECHLER. You really have been pretty much in the middle of this space tracking business, then?

Major HAMMOND. Yes, sir.

Mr. HECHLER. Did you have anything to do with following this unknown satellite?

Major HAMMOND. This recent one, sir?

Mr. HECHLER. Yes. This so-called mystery satellite.

Major HAMMOND. This is not really a NASA function. We do not have in any of the instruments that I discussed a capability of detecting a satellite if we do not know where it is.

Mr. HECHLER. But you followed some of the progress of various agencies in trying to track this satellite?

Major HAMMOND. Yes, sir. I personally did, out of pure interest, right.

Mr. HECHLER. I was rather amazed and I might say somewhat shocked by published reports that the space surveillance system of the Navy, which initially picked this up, had not turned its data over, with due speed, and I just wondered whether this is really true?

Major HAMMOND. I don't know, sir.

This Spasur system, as I understand it now, and I have been away from it for some time, is really a research and development device. Is it reported as an operational device?

Mr. HECHLER. You are not aware then that there was any delay?

Major HAMMOND. No, sir.

Mr. HECHLER. You don't believe there was any such delay?

Major HAMMOND. I don't know.

The CHAIRMAN. Any further questions?

If not, gentlemen, we want to thank you very much for your very fine statements. They were very illuminating.

Now, if there is nothing further, I would like for the committee to go into executive session for a few minutes. I want to present the program for the rest of the week to the committee.

Mr. FULTON. I ask the Navy to submit a short statement so we don't have any inference of delay without some statement in the record from the agency involved.

The CHAIRMAN. If the Navy wants to submit a statement, of course, it will be all right.

Mr. FULTON. I am asking for it.

The CHAIRMAN. The Navy hasn't requested it.

Mr. FULTON. I am asking for it, if you would be so kind.

The CHAIRMAN. Commander, would you undertake that responsibility?

Commander VAN NESS. Yes.

The CHAIRMAN. If you see Admiral Raborn, it would be all right to talk to Admiral Raborn.

(The information requested was submitted but is classified.)

The committee will go into executive session.

(Whereupon, at 3:55 p.m., the committee proceeded in executive session.)

(The executive session is classified and will not appear here.)

REVIEW OF THE SPACE PROGRAM

TUESDAY, FEBRUARY 16, 1960

HOUSE OF REPRESENTATIVES,
COMMITTEE ON SCIENCE AND ASTRONAUTICS,
Washington, D.C.

The committee met at 10 a.m., Hon. Overton Brooks (chairman) presiding.

The CHAIRMAN. The committee will come to order.

This morning we have the privilege of having the Secretary of the Army, Hon. Wilber M. Brucker, and his able Chief of Staff, Gen. Lyman L. Lemnitzer, both before the committee. We have had them previously, but this is more of a general appearance, and the other was for a special purpose. We are glad to have you.

Yesterday afternoon at an executive meeting the members of the committee, asked me to enforce the 5-minute rule. So I am going to call every member after 5 minutes and they are going to have to stop.

Mr. Brucker, would you care to give us your statement at this time.

STATEMENT OF HON. WILBER M. BRUCKER, SECRETARY OF THE ARMY

Secretary BRUCKER. Mr. Chairman and gentlemen, I welcome the opportunity to appear again——

The CHAIRMAN. May I interrupt you just a moment. Mr. Fulton asked me to announce that he will be late this morning. He is now attending a panel of the National Missile Space Conference and he will be along in just a little while. All right, sir.

Secretary BRUCKER. Mr. Chairman and gentlemen, I welcome the opportunity to appear again before the Science and Astronautics Committee of the House of Representatives. The matters which you are considering are of vital importance today and could conceivably become, in another few years, most vital to our overall position in the world—even to the security of our Nation itself. I particularly appreciate this opportunity to discuss with you the Army's contribution to our national space effort because the nature, scope, and potential of this contribution are sometimes not fully understood, even by some who are conversant with space objectives, activities and programs.

The other Army witnesses who will be appearing before you over the next 3 days are:

General Lemnitzer, Chief of Staff of the Army, who is appearing with me today.

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Lieutenant General Trudeau, Chief of Research and Development, and Major General Dick, his Director of Special Weapons, scheduled to appear tomorrow, and

Major General Schomburg, Commander of the Army Ordnance Missile Command at Huntsville, Ala.

May I also say that here with me this morning for additional counsel on these matters is Dr. Richard Morse, who is the Director of Research and Development of the Army, and who will represent me in my behalf as Secretary of the Army during any period of the next 2 days when Army witnesses are appearing.

This morning I propose to discuss in general terms contributions which the Army has made to the national space program since I appeared before this committee in February 1959, as well as the Army's policy and views with respect to its continued role and participation in the furtherance of this vital effort. General Lemnitzer is ready to discuss the Army's views on the military use of space and the Army's role and requirements in this area as we see them. The other Army witnesses are ready to provide greater details with respect to all of these matters.

In furthering the overall military posture and security of the United States, the Army will endeavor to contribute to the objectives set forth in our overall national policy. As you know, President Eisenhower has stated that our activities in space should be devoted primarily for peaceful purposes for the benefit of all mankind. This policy was ratified by the Congress in the National Aeronautics and Space Act of 1958, and the National Aeronautics and Space Administration was established and charged with the mission of conducting civilian scientific space exploration. At the same time, as the Congress likewise fully realized, our national security requires that we should not fail to exploit to the fullest the improved military capabilities which operations in space promise to provide. We must never lose sight of the fact that it is most difficult, if not impossible, to separate, in a technical sense, peaceful accomplishments from military capabilities in space. It is therefore our responsibility in the military to insure that we take advantage of every opportunity afforded by space exploration to strengthen our Nation's defenses and at the same time to insure that the military use of space by any potential enemy does not endanger our national security.

Potential military uses of space on the part of the U.S.S.R. will tend to increase the dimensions of the Communist threat, without necessarily replacing any element of that threat which presently exists. In fact, such an expansion of the threat might well have an effect comparable to the one we foresee resulting from the growing Soviet ICBM capability, in which the combination of this missile strength and the already large conventional forces of the Communist bloc may well encourage the Soviets to undertake bolder ventures with tactical forces, under the strategic "umbrella" provided by the threat of a thermonuclear holocaust.

The Army's efforts in space have been and will be directed to the accomplishment of two primary objectives: First, to strive for development of Army capabilities which will permit us better to accomplish our assigned missions of land combat and air defense; and second, to contribute, where we are best qualified, to the overall ad-

vancement of our country's national space program—both civilian and military.

Largely as a result of the explosive technological and scientific advances since World War II, it became fashionable in some quarters to jump to the unwarranted conclusion that the traditional and conventional methods of warfare—and particularly land warfare, the basic mission of the Army—were being eclipsed and had become obsolete. Fortunately for our national security, neither the Congress nor the other responsibile officials of our Government have been deluded by any such superficial approach. On the contrary, there is abundant evidence that the ability of the Army to engage successfully in any form of ground combat is more important to the security of the United States than ever before in our history. Despite the glamour of long range missiles and the boundless challenges presented by the possibilities of space exploration opening before us, we must never loose sight of the fact that man's home and life are on the land, and he is capable of existing outside his natural environment only to the extent that he is able to create an artificial environment for the time being and take it with him. We must never lose sight of the fact that if man does not control the land to which he must return, man cannot exist indefinitely, either at sea, beneath the sea, in the atmosphere or outside the atmosphere. The Army's interests and endeavors are therefore to use space to improve its capabilities to perform its vital mission of land combat and to defend the land from attack from any place, including an attack from the space above the land.

I should now like to review the Army's accomplishments in the year which has passed, to discuss the changes which have occurred during that period and, finally, to outline briefly the Army's plans for the coming year.

In accordance with our national policy to reduce duplication of effort and to obtain the maximum benefit from funds committed to our space program, all of the Army's efforts in the satellite and space vehicle fields have been conducted in an effort of either an integrated Department of Defense military space program directed by the Advanced Research Projects Agency or in support of the civilian scientific space program directed by NASA. The funds for these efforts have been provided to the Army by either ARPA or NASA from the funds made available to them by the Congress for satellite and space vehicle development. At the same time, the Army has been assigned by the Secretary of Defense responsibility for the development of the Nike-Zeus in order to provide an antimissile defense for the United States. The Army has conducted and funded this rapidly advancing Nike-Zeus program from the resources made available to the Army by the Congress.

During the past year the Army, which was the first agency in the free world to penetrate outer space; to develop large multiple-stage missiles; to accomplish the successful return and recovery intact of nose cones from outer space; and the first to orbit an artificial earth satellite, added additional firsts to this list of pace-setting accomplishments. On March 3, 1959, the Army, in support of NASA, launched the free world's first artificial satellite of the Sun, Pioneer IV, and on May 28, 1959, successfully recovered in a Jupiter nose cone two live monkeys, the first primates to have been transported

outside the atmosphere approximately 1,500 miles through space, and successfully recovered. During the same period our Nike-Zeus antimissile development program has proceeded on schedule, while at the same time achieving improvements in both the missile and its control system which will enable Nike-Zeus very substantially to exceed its original design objectives. Still another significant first was, as I am sure you have either heard or seen, achieved on the 29th of January 1960, when a Hawk air defense missile successfully intercepted and destroyed an Honest John ballistic missile at White Sands Missile Range. In response to a request from this committee we have brought with us a film of this firing and a film report on Nike-Zeus which we will be ready to show you in executive session after General Lemnitzer and I have completed our statements.

I would be remiss in reporting to you the Army space progress, present status, and future plans if I failed to mention the significant changes in organization which have occurred since last year. You will recall that at this time a year ago ARPA was responsible to the Secretary of Defense for the conduct of all military space research and development within the Department. It accomplished its mission by assigning to the various services responsibility for the development of particular projects for which they were either uniquely or particularly qualified. In September 1959, the Secretary of Defense assigned to the Air Force responsibility for the development, production, and launching of space boosters and for the integration into such systems of such payloads as might be developed by it or other services.

At the same time, the Secretary of Defense indicated his intention, which has since been implemented, of transferring to the Air Force the responsibility for the development of two major satellite programs, the Samos (reconnaissance satellite), and the Midas (early warning satellite). Subsequently, the Discoverer (an engineering development and test satellite) was similarly transferred to the Air Force by the Secretary of Defense.

The Secretary of Defense also indicated that assignment for development of the Transit navigation satellite and the Notus interim communications satellite to the Navy and Army, respectively, had been approved, but that the transfer dates would be determined later. These transfers have not yet been implemented, although the Navy is still developing for ARPA the Transit payload and the Army is still developing for ARPA the Courier interim communications payload.

Subsequently, on October 21, 1959, the President, as I discussed with you earlier this month, transferred from ARPA to NASA responsibility for the Saturn 1½ million pound thrust booster and decided to transfer from the Army to NASA the Development Operations Division of the Army Ballistic Missile Agency.

We in the Army recognize that these events have reduced significantly our capabilities and responsibilities for developing and launching integrated space vehicle systems, but I should like to emphasize that the Army still retains many and varied capabilities in its seven technical services which are contributing and will continue to contribute most significantly to space developments and progress.

At the same time, our efforts in this field complement and benefit our other Army programs since many techniques and hardware items, as, for example, in communications-electronics, have application in both.

The Army's micromodule and electronic component development programs have provided smaller, more reliable, and more versatile electronic parts for application in ground and airborne equipment and in satellite communications equipment as well. Here, then, is a case where our efforts have resulted both in benefits to all services in their assigned roles and in benefits to the national space program.

With respect to communications satellites, which I mentioned earlier, the Secretary of Defense is actively considering assignment to the Army of responsibility for development, under ARPA direction and funding, of the principal communications satellite systems. This significant program will be directed toward a 24-hour global communications system involving satellites at altitudes of thousands of miles and an extensive network of ground stations. Existence of such a system will assure reliable, adequate, and rapid communications for critical military operations in any part of the world. The initial system to be tested is called Courier and will provide a communications link of the delayed-repeater type, much like Project Score which directed President Eisenhower's Christmas message in December 1958 from a satellite-borne communications package.

The Army will accept this new task, if assigned, with enthusiasm and confidence.

In addition to the communications satellite program, the Army Signal Corps is conducting other satellite programs for ARPA and for NASA.

This represents the contribution, and the potential for still further contribution, by only one of the seven Army Technical Services. All of these Army Technical Services have the inhouse scientific and technological capability and the widespread contact with American industry to represent, in the aggregate, an organized and coordinated Army resource which can be rapidly oriented toward the accomplishment of almost any space project or program in the national interest.

Extensive Army capabilities also exist in the diverse fields of propulsion; mapping, geodesy, and selenodesy; ground-based engineering and logistic support systems; nuclear power systems; transportation; medicine; and many other related areas of competence.

During the coming year we plan to press forward at the maximum practical rate, consistent with available funds, the space and antimissile defense projects which I have already mentioned. In particular, we will continue to press vigorously the development of the vital Nike-Zeus antimissile missile. I support wholeheartedly, and without reservation, previous testimony before this committee that we must make every effort to provide a defensive capability against both the ICBM and offensive space systems. I am happy to note that the Air Force indicated to you that it has concluded that it will be possible to provide effective defensive measures against some offensive systems through the use of defensive military space systems. As you know, the Army has long been convinced that the Nike-Zeus will provide an effective defense against intercontinental ballistic missiles. You can be sure that the Army will bend every effort in the coming year to press development of the Nike-Zeus with the urgency it deserves and the top national priority for development which it enjoys.

In addition, the Army, until the Von Braun team's transfer actually takes place on July 1, 1960, will continue to conduct for the Na-

tional Aeronautics and Space Administration satellite firings and the Mercury Redstone firings which will lead to the free world's first launching of a man into space. NASA representatives have already described for you their plans for these programs so it is not necessary for me to elaborate on them at this time. We will also continue to press forward the Tiros meteorological satellite payload which the Signal Corps is developing for NASA and the Courier communications satellite development program I have described.

In summary, Mr. Chairman, during the past year the Army has made significant contributions in furtherance of the Nation's military and civilian space effort, it is in the process of contributing to the National Aeronautics and Space Agency what it considers to be the outstanding missile and space vehicle development team in the world, and it will continue to press forward vigorously with the extensive capability and competence it possesses to support the national program.

The CHAIRMAN. Thank you, Mr. Secretary. I want to say the way your statement impresses me, it is a ringing challenge to those that would write off the Army as a vital part of our defense program. I am glad you are taking a fighting, aggressive attitude in reference to the Army.

Secretary BRUCKER. Thank you.

Mr. MILLER. May I join you in that statement, Mr. Chairman.

The CHAIRMAN. As one old Army man to another, yes.

Secretary BRUCKER. Thank you very much.

The CHAIRMAN. Now, we have at this time General Lemnitzer, who is Chief of Staff of the U.S. Army. I think everyone has a copy of his statement.

General Lemnitzer, if you will, sir, we are happy to have your statement.

General LEMNITZER. Thank you.

STATEMENT OF GEN. LYMAN L. LEMNITZER, CHIEF OF STAFF, U.S. ARMY

General LEMNITZER. Mr. Chairman and gentlemen, it is a pleasure to meet with your committee again. I welcome this opportunity to discuss with you—in somewhat broader terms than on the occasion of my recent appearance before your committee—the very important subject of space, particularly the Army's interest, capabilities, and role in space.

At the outset, I would like to say that I feel that, at least for the time being, we must look upon space as an entirely new medium. It is a medium of untold possibilities—a vast, relatively unknown area which we are only beginning to explore. New technological discoveries and developments in the field of space are being made almost daily.

Accordingly, we should proceed to explore this new medium along rather broad fronts in both the civilian and military areas of interest. We must be sufficiently flexible to recognize quickly and utilize fully those developments made in either area which may have an applicability to the other. Similarly, at this state of our advancement into space, we must retain the maximum degree of flexibility—recognizing the extent to which the acquisition of unexpected capabilities may suddenly alter our concepts, plans, and programs.

Furthermore, the exploration and exploitation of this uniquely vast as well as entirely new environment will demand a substantial contribution in all fields—including scientific, industrial, political, and military.

With these thoughts in mind, I would like to outline briefly my views on the military use of space and the Army role in space, as we see it at this time.

Although the military use of space may ultimately produce new concepts of combat, for the immediate future space systems will be principally used to support terrestrial operations. Space systems can complement and extend present earth-based capabilities and techniques. In fact, in some respects they will make very substantial contributions. Offensive and defensive weapons systems in space are further in the future, are not as clearly defined, and at this stage, are primarily a matter for study and research. The extent to which actual military operations might be conducted in space, to include the land mass of the moon or of other celestial bodies, is still somewhat conjectural.

However, this possibility must be recognized, and the military space program should reflect these longer range considerations. In designing both the immediate and long-range aspects of our military space program, we must bear in mind that space, because of its potential for all of the military services, transcends the exclusive interests of any one of the services.

The Army plays an important and vital role in all forms of warfare, ranging across the entire spectrum—general nuclear war, limited war, and cold war. Within the context of this role, the Army's role and interest in space are initially directed toward the application of space to modern terrestrial warfare—more specifically, its application to the accomplishment of the Army's principal assigned missions in this environment. Stated briefly, these principal missions are—

To provide and support forces for land combat.

To provide and support forces for air and missile defense.

To provide a number of related services, not only for the Army but in support of the other armed services as well, including intelligence, communications, mapping, and geodesy.

The accomplishment of each of the foregoing Army missions would be greatly facilitated by space systems which we can visualize at the present time. For example:

Land combat forces urgently require surveillance and reconnaissance of hostile territory, which reconnaissance satellite systems should be able to provide.

Air and missile defense forces are vitally concerned with the early detection, identification, and location of hostile aircraft, missiles, or space vehicles, which space surveillance systems could provide.

Communications satellites will greatly increase the security, capacity, and reliability of our vital worldwide Army Command and Administrative Net, which provides communications service for many agencies in addition to the Army.

Proper performance of the Army's mission of providing mapping and geodetic service to all military services demands exploitation of space technology, particularly to gain vital and accurate information over extensive areas of the world.

We must visualize that successful performance of the Army's missions in the future—in an age of expanding space technology—will require application of additional space techniques and systems, as they are developed. For example, it may well become necessary to extend air and missile defense systems to provide defense against hostile satellites or other space vehicles.

The Army's ultimate role and interest in outer space—including operations on the land masses of celestial bodies—will be determined by strategic, tactical, and technological considerations that are still very far in the future. However, it is reasonable to assume that there will be an important role for the Army in this area—particularly at such time as we may be able to effect human lodgments on habitable celestial bodies.

As assets to apply against its requirements in the realm of space, the Army has developed unique capabilities. These are largely a natural outgrowth of the Army's pioneering efforts in missiles, communications-electronics, geodesy, selenodesy, construction, and survival and operations in extreme environments. Even after the planned transfer of a portion of the Army Ballistic Missile Agency to the National Aeronautics and Space Administration, the Army will still have a substantial capability to participate in space activities. The application of this capability in space is not restricted to Army requirements but can continue to contribute, as it has in the past, to our overall national space program.

Secretary Brucker has already discussed the Army's capabilities in missiles and communications-electronics. I would like to expand somewhat upon our capabilities and present work in some other fields.

The Army is especially experienced in geodesy, which is the science of determining the exact position of points on the Earth's surface, and the topography, shape, and size of the Earth. The Army is also making our first real topographic map of the Moon.

Similarly, the Army has a great deal of experience in constructing missile bases, launching and space tracking sites, and is engaged in developing and operating simulated environment facilities.

We are involved in important work related to radiation dose and spectrum measurements, shielding requirements, chemical oxygen production, toxicity studies, and other activities relating to the protection of man from biological, chemical, and radiological hazards.

We are also studying the biomedical aspects of Army missile programs—and are engaged in the development of nonperishable food pastes and tablets, the utilization of algae for food production and the development of special clothing, shelters, and handling equipment.

In addition, we are supporting national missile and space programs in managing the movement of personnel and materials, and in developing techniques for handling and moving missiles, space vehicles, and ground-support equipment.

In summary, the Army has a vital role and interest in space. It also has the capability to contribute materially to our overall space program—in both the military and nonmilitary fields. Based upon its missions and capabilities, the Army is interested in developing communications satellites, mapping and geodesy satellites, a space surveillance system, and an antisatellite defense system—as well as an antimissile system. You may be assured that the Army will continue to provide maximum support for our national space effort.

The CHAIRMAN. Thank you very much, General, for a very fine statement.

Now, members of the committee, at 11:30—it will take about 20 to 30 minutes to see this film, and it is classified and we certainly want to see it this morning. I think that will give everybody an opportunity to question the Secretary and the Chief of Staff.

However, you will recall that you asked the Chair yesterday afternoon to limit everybody to 5 minutes and I propose to do it.

Mr. Secretary, did the Army ever make any recommendations concerning how the space program should be handled, as far as the Army is concerned?

Secretary BRUCKER. You mean in the 1960 recommendations of the amendments to the act?

The CHAIRMAN. Yes, sir.

Secretary BRUCKER. We did not. You see in answer to the question the other day, the amendments were not presented to us prior to the time that they were included.

The CHAIRMAN. Now, did you make recommendations to the proper authority as to the future program of the Army in space? In other words, did you make a request for certain areas?

Secretary BRUCKER. We communicated our ideas on the subject to the Department of Defense. My answer related particularly to this bill that would amend the present Space Act. We did make our recommendations and have currently and right along made our recommendations with regard to the position of the Army, our readiness, our ability and our desires with respect to space.

The CHAIRMAN. Now, I notice in the press reports that the Army has apparently greater jurisdiction now in the use for tactical aircraft and I would think following that principle, that the same would apply for space aircraft or spacecraft.

Secretary BRUCKER. I wouldn't believe that that would make a difference that would justify us in going further with that, Mr. Chairman. I think, in other words, our use of tactical aircraft is in connection with the battlefield, but not beyond that.

The CHAIRMAN. I notice that in your statement and also the General's statement references to various phases of the space program which the Army will retain in the future. How was that set aside? Was that by Army action, Defense action, or did that go to the level of the Presidency?

Secretary BRUCKER. It is by Defense action. The Army requested that it be permitted to go forward with various of these suggestions that we had with reference to space. And it was at the express direction of the Secretary of Defense, back in September of 1959, that we were assigned or given the assignment for a communications satellite.

That was at our express request, and we have followed that up for the purpose of having the entire mission with regard to a communications satellite turned over to the Army.

The CHAIRMAN. Now, who has Notus, that is the interim communications satellite?

Secretary BRUCKER. That is the one that I referred to. That is covered by the name Courier. Courier is a project that is under the Notus program. Notus is the name for the overall program for communications, and Courier is one of the projects in that program.

The CHAIRMAN. Now, the Army doesn't have Transit, does it?

Secretary BRUCKER. No, Transit is Navy.

The CHAIRMAN. That is a Navy project?

Secretary BRUCKER. Right. That is a navigational project.

The CHAIRMAN. But you have Notus, and you have what other projects? You have Geodesy, which is mapping. And I notice, too, the Chief of Engineers, of the Army, has been making maps of the Moon. Sometime later we would like very much to have him down before this committee to tell us what he has done in that respect because that is certainly pioneering.

Secretary BRUCKER. Yes, the Chief of Engineers is in charge of that project and it is actively moving along.

The CHAIRMAN. That is under you?

Secretary BRUCKER. It is, under the Corps of Engineers.

The CHAIRMAN. My time has expired and I recognize Mr. Chenoweth.

Mr. CHENOWETH. Mr. Secretary, we are happy to have you and the general again with us here. We have great confidence in what you are doing down there. I think the American people share that confidence. We are, of course, always anxious to get more details. Mr. Secretary, how would you sum up the Army's role in this so-called space and missile age in which we are now entering? What impact has it had on the Army? Has it changed any of your basic concepts of thinking, basic training programs or weapons programs, just what has it done to the Army in recent years?

Secretary BRUCKER. It certainly has done a great deal to lift our gaze to the things that are out in the future, in space, and there is no doubt about the fact that it will have influence in some things that are very earthy, but in which we are now having a slant toward the space side of it. I will give you an illustration of it. We will take, for instance, this program for communications, and also reconnaissance. We are interested in both.

We feel that eventually, in both communications and reconnaissance, it will assist very greatly even the field commander in the battlefield. I say, that weather and other characteristics of the space phenomenon, and also reconnaissance—as to what there is on the other side, and any number of other things that I wouldn't want to go into in unclassified discussion. The Army would be interested in having this information communicated directly to the land forces.

In addition to that, we have the mission, of course, of providing air defense forces—Nike-Zeus, for instance. The Nike-Zeus, as you know, is the antimissile missile. It is a wholly new concept in one way and yet a gradual and natural progression of what we have already had in the highly effective Nike family.

The Army has been interested in batting down any aerodynamically supported vehicle, in the atmosphere. Up to the present time, until we reached out into space, that was a job that we were satisfied with, first, with the Nike-Ajax, but we found that we had to do even more because of the speed of the aerodynamic threat. So, we stepped that up and developed the second generation of the Nike family, the Nike-Hercules. The Nike-Hercules has become so powerful that nothing can live in the atmosphere—I mean by living, can exist in the atmosphere, within its range, because when it locks on, it is sure death.

That ranges up to over 100,000 feet; I can't indicate the extreme height of it, but it ranges in such a way that nothing can exist in the man-breathing atmosphere at all.

Mr. CHENOWETH. What is the status of the Nike-Hercules now?

Secretary BRUCKER. The status of the Nike-Hercules is that it is on site in different parts of the country and in different parts of the world. At the present time it is on site, I will give you an example, at two places in Alaska. There it is in such a splendid spot that it is able to defend that whole area. The Nike-Hercules can protect not only against the incoming planes, themselves, but it also has an added capability in its present range to protect against anything that may come in on the deck as well as at high altitudes.

The CHAIRMAN. The gentleman's time has expired.

Mr. Miller?

Mr. MILLER. Mr. Secretary, in the field of development you have demonstrated that the Army has great capacity. Now, as I see it you only are given—you are only in the program in one instance now and that is in the case of Courier. Courier is the only assigned——

Secretary BRUCKER. Courier, that is right.

Mr. MILLER. Only assigned satellite that has been given to you. Have you applied for any other work or does this occupy your full capability?

Secretary BRUCKER. Can I just respond first to the first part of your question: We have not completely been given that project. It has been indicated that ARPA would assign that to us and they have given us the opportunity to start on it. The actual assignment has not yet been made.

Mr. MILLER. In view of the fact that you have great demonstrated capability in this field?

Secretary BRUCKER. That is right. We are hopeful that we will get that. As a matter of fact, it was so indicated on February 11 of this year, just this last week, that it is getting closer, but yet the assignment hasn't been completely made.

Mr. MILLER. And you are willing to accept it if you do get it?

Secretary BRUCKER. With enthusiasm if we get it. We are ready, we have been working on it right along and we have made great progress on it, but the only thing I am calling attention to is that the assignment hasn't yet been made, actually made.

Mr. MILLER. Mr. Secretary, I am also concerned, very much concerned, with the defense against missiles. I think that in our effort to try and get ahead of the Russians we have overlooked this phase of it. Last year there was $137 million given to you by Congress for the development of the Nike-Zeus. Have these funds been released to you?

Secretary BRUCKER. No, they have not.

Mr. MILLER. Why, what is blocking them?

Secretary BRUCKER. The decision was made by the Department of Defense in the fall, last fall. It was at the time when the budget was submitted. On December 1, we are told that the $137 million will be placed in what is called a reserve for 1961. These were 1960 moneys you remember, Mr. Miller, and we were told that they would be placed in the 1961 reserve funds and that no preproduction or production money would be made available to the Army.

Mr. MILLER. I remember very distinctly in 1941 when we were in a bad way, Congress appropriated money and then the American people wondered why you couldn't go and take antiaircraft guns off the shelf; they weren't there. Aren't we putting ourselves exactly in the same position today that we were in then, when we are neglecting the development of this weapon that is presently about the only proven thing, the only one that has any great capability to it?

Secretary BRUCKER. The Army, as far as we are concerned is moving just as rapidly as it can. We are on schedule and I would like to give you the comforting assurance——

Mr. MILLER. But you could use that $137 million very successfully?

Secretary BRUCKER. As to the $137 million, we are desiring and—we don't feel that we are stopped completely on that. We are at the present time urging that there be reconsideration for portions of it so that we may go as far as we can on anything that we can get released. The Army, in other words, believes that it has something here that it can contribute for the good of everybody in the country. We want to do it and as rapidly as we can do it we are urging that we be given the funds for that purpose.

Mr. MILLER. General Lemnitzer, I would like to ask you as a military man: Do you see great importance in the Nike-Zeus program?

General LEMNITZER. Well I think it is obvious even to an amateur that it is highly desirable—in the light of the fact that ICBM's and submarine-launched missiles may be directed at this country—to have a capability to shoot them down. As a matter of fact, I consider it absolutely vital to our security in this oncoming ICBM age.

Mr. MILLER. Do you know of anything better that we have developed to date?

General LEMNITZER. No, there is no other active system of missile defense. I would just like to amplify what the Secretary has said, however. We are moving at the highest possible speed in the research and development phase on Nike-Zeus, and later on there will be explanations of what we have accomplished in this regard.

The issue, Mr. Miller, is in the field of going into what we refer to as preproduction. There are those who feel that we have not yet reached the stage where going into preproduction is warranted by the accomplishments in research and development.

On the other hand, we think differently about it——

Mr. MILLER. You think you should go into preproduction now? I don't have very much time.

General LEMNITZER. We thought differently about it, there is a difference of opinion on this. We have had our opportunity to present our case, but the decisions are just what the Secretary indicated.

The CHAIRMAN. Your time has expired.

Mr. Van Pelt?

Mr. VAN PELT. No questions.

The CHAIRMAN. Mr. Anfuso?

Mr. ANFUSO. Just one question.

Mr. Secretary, didn't you have a successful firing of a Nike-Zeus recently?

Secretary BRUCKER. Yes, we did. We had a very successful firing, completely successful, in the White Sands Missile Range, February 3, 1960, which is just a couple of weeks ago, as you see.

As a matter of fact, by request of the committee, we have a film here that shows the actual firing. We also have a film that is subject to your request here, too, to bring, on the Nike-Zeus system, showing just what it can do at the present time. That can speak, perhaps, better than I on the subject of what the ability is. We have great confidence in the Nike-Zeus. As a matter of fact, we are pressing for every day we can get and I may say to you that I not only have confidence as the Army Secretary but individually. I have seen it. I know what it can do. I know the progress we are making. I don't think anybody in the world doubts the fact that the missile is a good missile, and I don't think anybody doubts the fact that the propulsion and the launching and the system, itself, will do what we say it will do.

The question has been with reference to certain things that have been posed as things which must be encountered before it is completely successful. Those are things which require going into executive session to explain in detail.

Mr. ANFUSO. You have, Mr. Secretary, what is known as a military strategy board in which the Army, the Navy, and the Air Corps, and Dr. York sits, and reviews all of these programs.

Secretary BRUCKER. If you have in mind the—what is called the Missile Policy Board, there is a missile board in the Department of Defense. Then there is also a missile committee. Then there is also the Joint Chiefs of Staff. Now, those two agencies are side by side, but they are able to get together and from time to time the Joint Chiefs of Staff calls Dr. York in and from time to time the Joint Chiefs of Staff members appear before the missile committee of the Defense.

Mr. ANFUSO. It was this Board, Mr. Secretary, where Dr. York expressed the opinion that the Nike-Zeus needs more testing and more to show before he would go for it? Wasn't it at this Board meeting?

Secretary BRUCKER. I think it was at the Board meeting he first expressed it, although he has expressed it repeatedly since.

Mr. ANFUSO. Since this successful firing have you had another meeting?

Secretary BRUCKER. Since this February 3d?

Mr. ANFUSO. Since this February 3d. Do you propose to have one if you haven't had one?

Secretary BRUCKER. There has been no Board meeting that I know about since that time, but there is another committee has been set up that you should know about. Let me just add this, if I may for your information.

Mr. ANFUSO. Yes.

Secretary BRUCKER. It is called the Skifter committee, S-k-i-f-t-e-r. Mr. Skifter is a very renowned and reputed scientist in this field. This Committee has been assigned or given the job of reviewing the Nike-Zeus, both the potential and the progress and the scheduling and the rest.

Mr. ANFUSO. Tell us who is on that Committee, Mr. Secretary.

Secretary BRUCKER. I can supply those names.

(The information requested is as follows:)

DEPARTMENT OF DEFENSE NIKE-ZEUS ADVISORY COMMITTEE MEMBERSHIP
JANUARY 1960

Dr. H. R. Skifter, O.D.D.R. & E., chairman.
Mr. R. S. Morse, Director of Research and Development, U.S. Army.
Dr. J. V. Charyk, Assistant Secretary of the Air Force (R. & D.).
Mr. Tinus, vice president, BTL.
Dr. Bode, vice president, BTL (Murray Hill labs).
Brig. Gen. A. W. Betts, ARPA.
Dr. H. Beveridge, ARPA (alternate).
Dr. J. Wiesner, professor, electrical engineering, MIT.
Mr. C. Overhage, director, Lincoln laboratory.
Dr. A. Kantrowitz, director, Avco research laboratory.
Vice Adm. J. H. Sides, Weapons Systems Evaluation Group.
Dr. H. Bethe, professor, physics, Cornell.
Dr. Schilling, Raytheon Manufacturing Co.
Dr. Engstrom, vice president, RCA.
Dr. E. Purcell (consultant), physics department, Harvard.

Mr. ANFUSO. Is Dr. York on the Committee?

Secretary BRUCKER. No; he is not a member of the Committee. He sits as the research development man on the Missile Committee, as such.

Mr. ANFUSO. Supposing this Skifter Committee recommends it, could Dr. York's Committee then overrule it?

Secretary BRUCKER. It has the power to overrule it; yes, it does.

Mr. ANFUSO. So don't you think you ought to go before that Missile Board then in which Dr. York is in now as soon as possible?

Secretary BRUCKER. Dr. Morse, who is here with me now by my side, is a member of that group and he sits with them and relates to them the progress that is being made. So we are tied in on it.

The CHAIRMAN. The gentleman's time has expired.

Mr. Bass?

Mr. BASS. Mr. Secretary, referring to this Nike-Zeus controversy, as I understand it, as far as research and development is concerned, you are moving ahead as fast as you can; is that not correct?

Secretary BRUCKER. Let me answer that—I wish I could answer it categorically yes, but I can't. There is this reservation that I ought to give you: There is no doubt about the fact that in the President's message and in the statement of the Secretary of Defense it has been said that the Army is to go ahead full-scale on research and development. But Dr. Morse, here, has run into a situation where we have been told that less than the amount of money which was stated as the research and development portion of this will be released to us. Namely instead of $323 million, in the neighborhood of $287 million will be authorized.

Now, that means this, because if you cut the amount of the research and development money that is available at the present time, it relates back to things which are in being at the moment which are being processed. So I wouldn't want to categorically say yes to that and have you not know the reservation I just made.

Mr. BASS. I just understood General Lemnitzer to say that the issue was on preproduction rather than on research and development; is that not correct?

Secretary BRUCKER. That is correct, Mr. Bass, that is the issue. But there is this qualification that I speak about in connection with research and development, that you must have before you get into production or preproduction. We are striving at the present time to

get the money which will carry out and implement what the President has promised and what the Secretary of Defense has promised, and that is the full-scale amount for that purpose, but up to the present time we have moved as rapidly as we could and have been financed by it. The only reason I give you that caveat is because I don't want you to say later: "Why didn't you tell us about that?"

Mr. BASS. Up to the present time you are moving ahead as rapidly as you can. What you are concerned about is more money for future research and development; is that correct?

Secretary BRUCKER. That is right.

Mr. BASS. Now, you certainly wouldn't advocate, Mr. Secretary, would you, going into preproduction of a weapon system that hasn't been proved out as effective; would you?

Secretary BRUCKER. This is a question that I have to analyze, I think, out loud for you.

There is what is called a preproduction of material for components of Nike-Zeus. You have your whole system made up of components.

Now, of those components there are a number of items, such as modules, transistors, and other devices of electronic and other nature, some of them very tiny, miniaturized, that can be made in advance of the actual production itself. The purpose of the Army was to suggest that all of those things which could be done in advance of that time, simultaneously with the research and development end, and which would have a relationship to the whole program of not just the Nike-Zeus but other things in that field, that we go forward with that prior to the time that we put brick and mortar and concrete and the rest. My answer to you with regard to brick and mortar and concrete is that with respect to that, in that part of it, the Army has not made any representations or insistence upon that. Our question we raised was to release the amount of money which we could do simultaneously with research and development which we thought would not be duplicated or not be lost, and save time which would, of course, save considerable time by doing.

Mr. BASS. Am I correct in saying that the Nike-Zeus antimissile missile has not yet been effectively proved out as an effective antimissile missile?

Secretary BRUCKER. That is a difficult thing to say because as far as the missile itself is concerned it is in the course of research and development at the present time. It hasn't, of course, been shot at an ICBM, if that is what you mean.

Mr. BASS. That is right.

Secretary BRUCKER. We are going to do that in the Johnson Island-Kwajalein affair.

The CHAIRMAN. Mr. Sisk?

Mr. SISK. Mr. Secretary, just pursuing briefly the question on the Nike-Zeus, actually this situation with reference to moving ahead at the maximum capability of the Army is in almost the same situation it has been in since 1957, for some 3 years, isn't that true? Isn't going far back as late as late 1957 and early 1958, if I am not correct—I believe I am correct on statements made at Huntsville to us, and on other occasions that is, there has been a lack of really a decision to push ahead full scale on Nike-Zeus? Isn't that true, this actually is not something that is just new today?

Secretary BRUCKER. Well, this is not new today, the decision not to press ahead on Nike-Zeus. It is something that has been going on for some time.

Mr. SISK. That was the point I wanted to bring out, because certainly we had statements, as I recall, back in—I am sure as far back as 2 years ago and it seems to me a little further back than that, where from General Medaris and others on this Nike-Zeus program, where they were eager and anxious and yet lacking decisions and lacking money, they were unable to go ahead at their maximum speed. I realize you, with such funds as you have had, have moved ahead as rapidly as possible and I appreciate what has been done. But the point I wanted to bring out, the situation you are confronted with now in the sense of not having sufficient funds to do some of the things needed to be done is not something that just happened in 1960 or 1961 budget.

Secretary BRUCKER. No, it didn't start now. As a matter of fact, 2 years ago when I testified before the House Armed Services Committee, Dr. Von Braun and General Medaris and many others in the Army field, and experts, including my Chief of Research and Development and others urged that that be done. We went before that committee, and at that time after the hearing Congressman Vinson wrote a letter to Secretary McElroy and suggested that the Army be permitted to go into preproduction at that time.

Mr. SISK. Thank you. I want to ask General Lemnitzer one question. I am watching the clock, you know.

Secretary BRUCKER. All right.

The CHAIRMAN. So am I, I am watching it, too. [Laughter.]

Mr. SISK. General Lemnitzer, I was somewhat startled the other day in reading some testimony before a committee over in the other body given by General Twining. And my amazement was due to the fact that I have spent some time at Huntsville from time to time and visited there during the final development of Jupiter and it is my understanding that General Twining in his testimony before the joint hearing of the Senate Aeronautical and Space Sciences Committee and the Preparedness Investigating Committee emphatically denied that the Jupiter missile is mobile. Now, it was my opinion that the Army designed the Jupiter missile system to be a mobile system. Now, I would like to have your opinion as to the mobility of the Jupiter system as designed and visualized by the Army. Would you comment on that?

General LEMNITZER. The Jupiter was designed by the Army as a mobile missile. We had the handling equipment for it, and mobility was basic and fundamental to the entire Jupiter program.

I presume that General Twining's statement was based on the fact that the Jupiter today is not mobile. We turned this missile over to the Air Force in accordance with a decision made by the Secretary of Defense several years ago. The Air Force, in taking it over, did not concur with the mobility concept which we had, and I presume that General Twining's statement is based on the fact that today Jupiter is not mobile. I want to emphasize, however, that during the entire Army development of Jupiter, it was designed and developed as a mobile missile by the Army.

Mr. SISK. I actually had an opportunity to see a demonstration of the mobility of the weapon.

General LEMNITZER. Yes, sir.

Mr. SISK. During its ultimate development, and I was amazed here: I can see that apparently they have, by the method they are attempting to use, simply made it immobile.

Mr. SISK. That is all.

The CHAIRMAN. The gentleman's time has expired.

Mr. RIEHLMAN. Mr. Chairman, I would like to ask Dr. Morse one question and I think the committee would be interested in his appraisal of it.

Would you give the committee as briefly as you can your appraisal of the Nike-Zeus program and its potential?

Dr. MORSE. That isn't something I can do in 5 minutes, I am afraid. [Laughter.]

Mr. RIEHLMAN. I would like to have you give us what you can in 5 minutes.

STATEMENT OF DR. RICHARD S. MORSE, DIRECTOR, RESEARCH AND DEVELOPMENT, U.S. ARMY

Dr. MORSE. Well, I have spent a very substantial part of my total time in my job on Nike-Zeus, particularly in the last 6 weeks. I am very glad to do this.

The problem of defense against an ICBM, as you gentlemen are well aware, probably represents one of the most formidable technical problems that this country has faced. I think it is against that background that you should look at Nike-Zeus or any other system. Nike-Zeus is being well directed; it is being run by, in my opinion, the most competent group of industrial contractors that we have in the United States or anywhere in the free world, and I am currently very much impressed with the growth potentials which have been demonstrated in Nike-Zeus, the rapid progress which has been made in the sense of technical breakthroughs, all of which, in my view, tend to confirm the fact that we should proceed as rapidly as possible with the research and development of this system.

The opponents of Nike-Zeus—and there are many—in general have made certain major premises with respect to its effectiveness. These, for example, call for a massive attack on the United States with hundreds of ICBM's all arriving on target at essentially the same time. This is not a simple thing to do, even for the Russians.

Nike-Zeus has a demonstrated capability in the sense of its computers. We have had a very successful firing within the last 2 weeks; by that I don't mean a firing outside the Earth's atmosphere, but a firing which was on schedule, which gave us many of the data which we required, and I have never seen a better-run program of this complexity in my tenure in office of work here in Washington.

There are a lot of problems still to be solved. I think they will be solved. It is the only system that I am aware of—I think I am aware of all of them—that any one of the three services is currently seriously contemplating. We have in ARPA expenditure of some $100 million, for example, current rate of expenditure, in an effort to find other solutions to the ICBM problem. I am familiar with all of these.

I don't think any technical person would disagree with me when I say that none of these yet looks sufficiently promising to spend any money on in the sense of hardware. So Zeus today is the only answer that anyone has been able to come up with to solve the very dire situation which we have in this country, in the sense—as of today we have zero defense against ICBM or even detection.

Mr. RIEHLMAN. Doctor, would you give for the record your position that you hold with the Department?

Dr. MORSE. I am Director of Research and Development for the Army.

Mr. RIEHLMAN. That is all, Mr. Chairman.

The CHAIRMAN. Doctor, at this point I would like to swear you in. All the witnesses in this hearing have been sworn in except yourself. [Laughter.]

Do you solemnly swear the testimony you are giving before this committee in matters under consideration will be the truth, the whole truth and nothing but the truth, so help you God?

Dr. MORSE. I do.

The CHAIRMAN. All right.

Mr. McCormack?

Mr. McCORMACK. You said, Dr. Morse, and the doctor is one of our most dedicated Americans, I know him very well and I am glad to see him before this committee—the opponents of Nike-Zeus and they are many. Will you give just a little amplification of that now? [Laughter.]

Dr. MORSE. I don't intend, Congressman McCormack, to use the word opponent in a derogatory sense.

Mr. McCORMACK. No, I didn't——

Dr. MORSE. I referred to honest differences of opinion between both technical people and pseudotechnical people who have tried to look at Zeus and the general ICBM threat. And we are trying to arrive, I say the opponents are, for example, at a rational appraisal of a system which to date has many technical problems, but they are being solved currently and rapidly and in an orderly manner, I am sure of this.

Mr. McCORMACK. Let me ask you this question: As you are now testifying and, having in mind the future of our great country, and I know those thoughts went through your mind the same as it does every one of us, trying to do the best we can to preserve our way of life, are you satisfied that the Nike-Zeus is the only defense workable in the foreseeable future that we have now?

Dr. MORSE. Nike-Zeus as far as I am concerned is the only conceivable answer to which we have to shooting down an ICBM in the next 5 years. Minimum.

Mr. McCORMACK. Do you say the same thing, I will ask you the same question, Mr. Secretary.

Secretary BRUCKER. I answer it exactly the same way. I know of nothing else that we have or will have in the immediate or foreseeable future, and we have gone over the whole gamut of it, other than the Nike-Zeus. While there are studies going on in other fields, this, in my opinion, is exactly as Dr. Morse has said, is the only one.

Mr. McCORMACK. I will ask General Lemnitzer.

General LEMNITZER. I agree with those comments.

Mr. McCormack. Now, is there any division of opinion on the high level of the Defense Department that it is a waste of money to try and devise any kind of defense against ICBM's? [Laughter.]

Secretary Brucker. Do you want to have—[laughter] I got it. There isn't any reason for my impugning the motives of any person anywhere on this, but there are varied opinions in the spectrum all the way from what you said on through. In other words, there are a lot of people who have talked on this subject or discussed it who have varying opinions and I wouldn't want to say that there is any consistent opinion, either of opposition or otherwise, that entertains that view. But I would say that there are those who oppose us.

General Lemnitzer. I would like to augment that, because I think that this question should be answered in its entirety. I do not want to indicate that the comments I am making refer to anyone in the Department of Defense, but I have heard, frequently, within and outside the Department, the suggestion that the ICBM problem poses insoluble problems for this country.

In my opinion, they are taking a very defeatist attitude in this regard. This country has not been used to agreeing that problems are insoluble, and I don't believe this one is. As a matter of fact, I feel certain that it is not.

The opinion expressed is that we should put all of our resources in offensive-type weaponry, rather than in defensive weapons.

Now, I yield to no man on the desirability of, or the fact that you only win with, offensive systems. You never win by taking a solely defensive attitude. But warfare has proved throughout history that a certain amount of defense is absolutely essential if you are ever going to be able to utilize your offensive systems, particularly if you have the philosophy and outlook on warfare that we do—that we will not strike the first blow or launch a surprise attack.

Therefore, this being our philosophy—and I agree with it—we have no alternative other than to work hard, very hard, at getting enough defense to insure that we are not wide open to a surprise attack that may destroy us or prevent the employment of any offensive system which we have available.

Mr. McCormack. Mr. Secretary, have you looked over the amendments? I have called it to your attention before, before this committee. I agree with you we should never—

lose sight of the fact that it is most difficult, if not impossible, to separate, in a technical sense, peaceful accomplishments from military capabilities in space. It is therefore our responsibility in the military to insure that we take advantage of every opportunity afforded by space exploration—

and so forth—

to strengthen our Nation's defense.

Now, have you looked over the bill?

Secretary Brucker. I have looked over the bill since I have been here and the Army's staff has been coordinating it with the—the technical services and I will discuss it later on.

Mr. McCormack. You will make recommendations later?

Secretary Brucker. Yes, later on.

The Chairman. The gentleman's time has expired.

Mr. Karth?

Mr. KARTH. Mr. Secretary and gentlemen, it is very nice to see you again.

I would like to follow up Mr. McCormack's questioning of General Lemnitzer, I would like to ask you this question, sir: Is it therefore your oponion that the lack of an antimissile missile system presents a very serious hole in our military posture?

General LEMNITZER. Yes, as I indicated before, this is apparent to everyone. In the past, if we had not put up any air defense we would have been wide open to a bomber attack. We didn't accept such a situation. We have today a very substantial defense against manned aircraft. The situation would be parallel—even more serious, in my opinion—if we were not able to develop an antimissile missile of the Nike-Zeus type.

Mr. KARTH. Knowing what we know, General, what the Russian missile capability will be in 1961 and 1962, is it therefore your opinion that we treat an anti-missile-missile system with a sense of urgency that borders perhaps on a crash program basis?

General LEMNITZER. Not necessarily on a crash program basis. I think there are some that would so describe it. I regard—and as a matter of fact, I think this should be made clear—the development of an anti-missile-missile weapons system is one of the highest priority programs in this country today. It has been so assigned by the National Security Council. I think that gives a fairly good indication of the importance of developing such a system.

Mr. KARTH. General, who specifically decided that we should not go into the Nike-Zeus preproduction program?

General LEMNITZER. Well, we received our direction from the Department of Defense.

Secretary BRUCKER. December 1, 1959.

General LEMNITZER. We received it in response to a request which we made for the funds which have been discussed here earlier. We received our information from the Department of Defense.

Secretary BRUCKER. Maybe I can just add to that this: That we requested on October 22, 1959, that these funds be released which had been provided and the December 1, 1959, document from the Secretary of Defense was the answer to that request.

Mr. KARTH. One last question, Mr. Chairman:

Do you have any reason to believe and if you wish not to answer this question, certainly you don't have to but is there any reason for you to believe that some of this decision not to go ahead may be budgetary in any sense of the word, rather than tactical or scientific?

Secretary BRUCKER. One would just have to speculate on that. The reason that has been assigned is a reason that we have not yet proved out, as has been said here, the Nike-Zeus system as against an incoming ballistic missile.

Mr. KARTH. Yes, sir, but the Atlas system wasn't proved out before it went into production either, was it?

Secretary BRUCKER. No, it never was, that has been our argument. That we are being given conditions which were not posed against some of those other weapons. I don't want to get into any interservice rivalry by saying it.

Mr. KARTH. I understand.

Secretary BRUCKER. But, if the same ground rules occurred, we would be permitted to go forward. That has been the statement that we haven't proved it out, yet.

Mr. KARTH. Thank you, Mr. Chairman.

The CHAIRMAN. Mr. Hechler?

Mr. HECHLER. Mr. Secretary, you would concur, I gather with General Lemnitzer's statement of a few minutes ago that Nike-Zeus is, and I use his exact words, "absolutely vital to our security"?

General LEMNITZER. An effective antimissile-missile system is, and we believe the Nike-Zeus has the promise of developing into that kind of a system.

Mr. HECHLER. Mr. Secretary, you would concur with this statement by General Lemnitzer, would you not?

Secretary BRUCKER. Yes, I do.

Mr. HECHLER. And do you feel that our overall national security would be improved if we could go into production of an antimissile missile at the earliest practicable date?

Secretary BRUCKER. Oh, yes, at the earliest practicable date I would feel that way. The question, of course, turns on what that date is and when it is practical, and that is where the dispute lies.

Mr. HECHLER. I was interested in your statement on page 10, the last sentence of the paragraph on page 10 where you said—

> You can be sure the Army will bend every effort in the coming year to press development of the Nike-Zeus with the urgency it deserves and the top national priority for development which it enjoys.

Secretary BRUCKER. That is right.

Mr. HECHLER. I submit that it could hardly have top national priority if $137 million is put in reserve at a time when you need that money urgently. If that be top national priority, why we should put all your money in reserve and then you might get ahead faster. I can't get that through my thick head.

Secretary BRUCKER. I must concede this, that I have been overruled on that, and my guidance is this on it. This is not ready for production and therefore until you gentlemen qualify it for production we are not going to give you the green light. From the standpoint of somebody deciding things in Government, somebody has got to do it. We have urged it, but we have been turned down on it, on December 1, and that is our guidance.

Now, as I said just previously to you here, I don't consider that guidance as binding as against our reapplying from time to time for any or all of it, if it is necessary, in the days to come, I feel that the country's interest requires that we reevaluate this, month by month, and that if I find, as I have with respect to a part of this, that we should reapply for some of it, I am going to reapply.

Mr. HECHLER. Mr. Secretary, if a decision were made tomorrow that we should proceed toward preproduction and the earliest practicable production of Nike-Zeus, how soon could we have it?

Secretary BRUCKER. That is something I would have to go into a classified session on, because the date of this and the amount of time that we would save in preproduction and the amount of time that it takes to produce it are at this time classified.

Mr. HECHLER. I will ask General Lemnitzer this: Are there any aspects of the Nike-Zeus system on which it would be practicable to proceed with production now?

General LEMNITZER. None, other than those mentioned by the Secretary. We feel that it would be advantageous to develop production facilities on components which we know will be required in any system of this type, such as modules and transistors. Developing the ability to produce them in large quantities. That is the problem that faces us.

Mr. HECHLER. You feel it would help the defense of our country to proceed to the production of those elements of the system?

General LEMNITZER. We think it would because we feel it will substantially reduce the time required to put operational units on site after the system is proved out, and we are given the green light to go ahead on it.

Mr. HECHLER. No further questions, Mr. Chairman.

The CHAIRMAN. Mr. Daddario?

Mr. DADDARIO. Mr. Secretary, on page 8 of your report you refer to the fact that the transfer of the Von Braun team has reduced the capacity of the Army in the space vehicle system field.

Secretary BRUCKER. Yes.

Mr. DADDARIO. And on page 3 you refer to the increased dimensions of the Communist threat in the space field. Now, how has the transfer of the Von Braun team reduced your capacity, the Army capacity, to meet the increased Russian threat?

Secretary BRUCKER. In just this way: We had an inhouse capability that was unique, and I want to be humble when I say it, I think it was the best scientific team in the world, or is, at the present time.

Under those circumstances, with an inhouse capability in defense, or in the Army to put it plainly, we feel that we had both the capacity and potential for missiles as well as space vehicles. We felt that was the place where we could score and keep on scoring as we had with these other things that have occurred.

There were a couple of decisions that changed that. One was a decision by the Department of Defense in September that the Air Force would take over the manufacture, launching, and all characteristics, including the necessary integration, of space boosters for the Department of Defense.

The second decision was that the Saturn project, which we were producing and had for a year prior thereto, should be transferred to the NASA. Under those circumstances, of course, it became untenable for the Army to take any position other than to say we will keep this team together as a national asset, rather than have it divided, part for the Army and part for NASA.

Now, since that time and up to July 1, we will still have the team with us, but after that date it will be under the new management of NASA. It will be at the same location, with the same people doing the same things, namely, producing Saturn and other things. It will be available in the sense that the Army is located there. The Army is going to support and logistically provide a number of things for NASA. Under our arrangement, ABMA will continue to have that relationship, but it will be primarily, this time, a NASA operation.

To that extent, of course, our inhouse capability has been lessened. But that does not, of course, lessen the other things that we are interested in; the seven technical services, and also our ability to have other scientists who are down there at Huntsville in what we call the ARGMA, the Army Rocket and Guided Missile Agency, and the balance of those who are in the ABMA, which we will retain, that will still give us a capacity there.

But, of course, it does remove the inhouse capacity of that Von Braun team from us, but leaves it for the country.

Mr. DADDARIO. General Lemnitzer, in your statement you have referred to the fact that space is only important insofar as it is able to help our ground forces carry out their missions. I wonder——

General LEMNITZER. I want to be sure that you do not misinterpret my remarks. I said that space presently is only important insofar as it will support operations on the surface of the Earth—not necessarily ground operations, but space can be utilized now, as we see it, primarily to support the Army, Navy, and Air Force type of operations on the surface of the Earth.

Mr. DADDARIO. Well, although it is perhaps a little far afield from space, I wonder if our ground force capacity in such places as Korea, where we interdisperse Korean nationals with our own troops and what effect this has on our ground force capacity in this age and in the threat that we face in North Korea at this time?

General LEMNITZER. Well, I presume that you are referring to the situation which developed during the Korean war where we did have Korean soldiers assigned to most American units. These members of the Republic of Korea Army were known as KATUSAS, Korean Augmentation to the U.S. Army. That is the name applied to them.

We utilized Koreans with our Army forces in Korea during the entire Korean war. They were extremely valuable, and there was a very important mutual benefit. Operating in a country where we were not very proficient with the Korean language, KATUSAS were most useful in getting information for us, and in interviewing the people for intelligence purposes. On the other side of the coin, their service with the American units was very helpful in training them for the organization of their own army. The training which they received operating with American units was invaluable in putting together the fine units of the Republic of Korea Army which we had during the Korean war and which we have today.

The CHAIRMAN. The gentleman's time has expired.

General LEMNITZER. Could I finish this one, Mr. Chairman? I think it is important we get this matter very clear.

The CHAIRMAN. All right.

General LEMNITZER. In Korea today we have two American divisions. I know the basis for your question, Mr. Daddario, because it has been raised frequently in the hearings that we have participated in throughout the Congress.

We have in Korea two American divisions. We would like to have them fully—100 percent—manned with Americans. However, because of personnel limitations and the requirements of the many missions that the U.S. Army is required to fulfill throughout the world, we are not able to do so.

So, we are still employing KATUSAS with those two U.S. divisions in Korea. Now, if we did have these divisions manned 100 percent with American personnel, I would like to say also that from the viewpoint of training and the assistance which they could give us, as they did during the entire Korean war, we would still have the need for KATUSAS to serve with those U.S. divisions. We would, of course, prefer to have the divisions manned 100 percent with Americans with KATUSAS reinforcement.

The CHAIRMAN. Thank you, General. Mr. Moeller? May I say this, too, we will go into executive session at 25 minutes to 12 so that we will have time for that film.

Those that are not—thus far have not had an opportunity to question the witnesses, I am sure the Secretary will be here at the end of the film.

Secretary BRUCKER. Yes.

The CHAIRMAN. And so will the General, and they will have an opportunity to question at such time.

Now, we have one or two more.

Mr. MOELLER. Just two brief questions, General. On page 4 of your statement, speaking of the Army's mission in the future, you make the statement that it may become—

> necessary to extend air and missile defense systems to provide defense against hostile satellites or other space vehicles.

Could there be, then, some refinement, possibly, of the Nike-Zeus to accomplish what you have here stated, or do you have something else in mind for this?

General LEMNITZER. We believe that the Nike-Zeus has a limited antisatellite capability even under the program which is presently under development.

Mr. MOELLER. But if it were further refined, it could possibly accomplish this very thing?

General LEMNITZER. Yes. We feel, following the pattern of Nike-Ajax being extended in its capability by the Nike-Hercules program, that there is no reason why the Nike-Zeus couldn't be extended similarly into an antisatellite weapons system.

Mr. MOELLER. The other thing is this, in modern warfare naturally armed forces are pitted against one another and sometimes, of course, civilians suffer with this, also, many times.

Now, as far as we are concerned, something like the Nike-Zeus is the only civilian protection we have. Is this correct?

General LEMNITZER. It is the only antimissile-missile weapon system that is on the horizon at the present time. The others, as the Secretary pointed out, are only in the study phase. The Nike-Zeus—the missile itself, as you will see later—is presently in the hardware stage. The entire Nike-Zeus weapons system is not entirely proven, but it will be proven in our Johnson-Kwajalein Island test.

Mr. MOELLER. I want to waive my time, but I think this is something that the civilian populace ought to take a very keen interest in.

The CHAIRMAN. Thank you. Mr. King?

Mr. KING. In President Eisenhower's message to Congress January 14 he said with the repeal of the statutory enumeration of Presidential duties, the National Aeronautics and Space Council should be abolished, since its only function is to advise the President and so on. He

also stated, "The Civilian-Military Liaison Committee should also be eliminated."

Now, it has been said that by eliminating these two councils or agencies, you have removed, perhaps, the last and only machinery left for bringing about close coordination of effort between the military and the peaceful aspects of our total space program.

Would you care to comment on that, Mr. Secretary?

Secretary BRUCKER. I see no harm in the recommendations as such, but the reason that I replied as I did to Mr. McCormack, along the same line when he asked me the question briefly, was this: We haven't completely coordinated our study on it.

We do have a feeling that for two agencies that should be as closely connected as this, that something in the nature of the Atomic Energy Commission's relation with the Department of Defense might be a very good structure to consider. That is the military liaison committee, not a Civilian-Military Liaison Committee such as is in this bill or in the previous act, but a military committee, putting responsibility upon the military to provide the liaison with the other agency.

It works well with the Atomic Energy Commission and we are studying it. We are going to give you the results of our study, as I promised Mr. McCormack here, as soon as we get through coordinating with each of the branches of our service. That is the main thing we have in mind in answer to your question.

Mr. KING. You feel then that more will have to be done to bring these a little closer together but that this is not the final word?

Secretary BRUCKER. I think more is desirable, maybe that is a better way to put it, for this reason: Here are two heads of Government who are expected to get together, but in the busy life it is hard for them to do that, unless there is something that brings them together.

Now in this, the responsibility ought to be on the military under this circumstance to have it, to have a military liaison committee and have the military, the Department of Defense take the initiative. Somebody always has to do that in Government. If they don't the project falls somewhere between the chairs.

That is why we are studying this thing, to come up with something that is more definite. I don't want to go on record and say this is all thought out and complete and here is the amendment. We lean very strongly in the direction of saying that it is our obligation over at the Pentagon to make that military liaison complete and that the previous one didn't work too well.

I understand that, because it was on a bilateral basis and neither one would take the initiative or whatever it was. But in this the military ought to take the initiative and keep this liaison with the space agency.

Mr. KING. Will Congress get the benefit of your thinking as soon as it has matured on this subject? We have a practical problem of going ahead.

Secretary BRUCKER. Yes——

Mr. KING. And recommending legislation.

Secretary BRUCKER. May I say this, the only reason we haven't brought it over to you to date in semifinal form is because we respect your committee enough not to give you something that is incomplete. We will be able to get the thing over here in the next couple of days,

we hope. I think in the meantime we ought to indicate to you the direction in which we are thinking about it.

Mr. KING. Thank you, that is all.

The CHAIRMAN. Now, Mr. Roush is the only one who hasn't had an opportunity to ask any questions. When the film is completed, we will give him any opportunities. And Mr. Fulton——

Secretary BRUCKER. I would be perfectly willing if you want to have the questions completed and then stay.

The CHAIRMAN. How long will this film take?

Secretary BRUCKER. About 28 minutes.

Mr. FULTON. Mr. Roush is the only one left.

The CHAIRMAN. All right. We will hear you, Mr. Roush.

Mr. ROUSH. If they will make their answers brief, my questions will be brief.

I want to preface my questions with a remark and that is that I have a very keen feeling for the U.S. Army. I wear the Combat Infantryman Badge which the colonel with you gentlemen wears, and I have been disturbed because of what I think is lack of attention to the Army's part in our space program, especially in view of the fact that we have proved ourselves so successful in so many different areas.

The question I have concerns the project Saturn. I understand that the Army must have felt that there either is or there will be a military use for a large booster engine, is that correct, General Lemnitzer?

General LEMNITZER. Saturn was originally an ARPA project. It was an effort to build a booster of about 1½ million pounds of thrust, and on that basis it was regarded as a program that was important from the military point of view; yes.

Mr. ROUSH. During the time that Saturn was under the Army's jurisdiction, you had difficulty getting funds for project Saturn, too, did you not, sir?

General LEMNITZER. Well, we utilized the funds that were allocated to us by ARPA. You see, the funds were not appropriated as a part of the Army appropriation.

Mr. ROUSH. All right. The Army was always looking for more funds for Project Saturn, was it not, sir?

General LEMNITZER. Yes, our people in the Army Staff and at Huntsville were pressing for more funds.

Mr. ROUSH. And on one occasion, the funds which were allotted to you were actually cut down, were they not, and that was as late as the latter part of 1959?

General LEMNITZER. This is correct.

Mr. ROUSH. And in Nike-Zeus we can't get our funds. Sir, can you tell me, is there any reason why it is that these programs which the Army has been interested in has had so much difficulty with the Department of Defense in getting their funds? The other services seem to get them and here we have two programs which are absolutely vital to the security of America, absolutely important if we are going to get ahead and catch Russia in this space race, and yet we can't seem to get funds. Is there any rhyme or reason to that, sir?

General LEMNITZER. I don't think the Army has a monopoly on not getting funds for certain projects because I happen to know that some of the other services also have had funds withheld.

Mr. ROUSH. What program, sir, does the Army have right now which has a top priority insofar as our space program is concerned?

General LEMNITZER. Nike-Zeus has the highest national priority for research and development.

Mr. ROUSH. But just for research and development?

General LEMNITZER. This is correct.

Mr. ROUSH. How much money would it take during the fiscal year 1961 to get Nike-Zeus on its way?

General LEMNITZER. Nike-Zeus will continue to be on its way in R & D, and test and evaluation stage in 1961.

Mr. ROUSH. I am talking about production.

General LEMNITZER. There will be no preproduction unless additional funds are made available.

Mr. ROUSH. How much would it take, sir? That was my question.

General LEMNITZER. We estimated that $137 million could be used to advantage for preproduction purposes.

The CHAIRMAN. Now, at this point the committee will go into executive session to see this film that we have heard so much about. We want to thank you, Mr. Secretary and General, for both appearing here. We are very happy to have had you.

I want to make the announcement for the benefit of the committee that the committee this afternoon will meet at 2:30 rather than 2 o'clock and we well hear Richard E. Horner, Associate Administrator of NASA, at that time, and he will address himself to the bill H.R. 9918, NASA authorization for fiscal year 1961. So I urge all the members to be back at 2:30.

(Whereupon, at 11:42 a.m., the committee proceeded in executive session.)

(The executive session is classified and will not appear here.)

REVIEW OF THE SPACE PROGRAM

TUESDAY, FEBRUARY 16, 1960

House of Representatives,
Committee on Science and Astronautics,
Washington, D.C.

The committee met at 2:30 p.m., Hon. Ken Hechler presiding.

Mr. Hechler. The committee will come to order.

Today we have testimony by Abraham Hyatt, Deputy Director, Launch Vehicle Programs, for NASA.

Mr. Hyatt, do you have a prepared statement?

Mr. Hyatt. No, sir, I do not.

Mr. Hechler. Do you have some comments you wish to make?

Mr. Hyatt. Yes, sir.

Mr. Hechler. Proceed in your own way, Mr. Hyatt.

STATEMENT OF ABRAHAM HYATT, DEPUTY DIRECTOR, LAUNCH VEHICLE PROGRAMS, OFFICE, NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

Mr. Hyatt. May I have your permission to speak near the charts?

Mr. Hechler. Yes.

Mr. Hyatt. Mr. Chairman and gentlemen, in earlier testimony Dr. Dryden and Mr. Horner have informed you about the national booster vehicle programs and mentioned the vehicles that make up this program. I shall discuss the vehicle program in greater detail and also bring you up to date on the developmental status.

Before I do that, I would like to mention three points:

The first point is that the state of the art in vehicle development is not such that a new vehicle can be designed, manufactured and launched with an expectation of a high probability of success for the early flights. In every one of these space vehicles there are hundreds of sequential operations that must all work successfully, otherwise the vehicle will fail.

The second point is that in the future our vehicles will be larger, they will be designed to perform more complicated missions over a wider range of environmental conditions and for much longer periods of time. Consequently more vehicles will have to be assigned to the development phase if we want to have a high degree of confidence for the operational vehicles.

Finally, in order to minimize the effects of these two situations, every effort is being made to develop the smallest number of vehicles which will encompass the entire range of presently envisioned missions. It is the objective of the NASA to use every vehicle type for a number of missions even though each vehicle may not be optimum for

every one of the missions. This allows us, in time, to use the same type of vehicle over and over again, thereby achieving a high degree of reliability. And of course, as we attain reliability, we experience fewer failures and achieve our objectives faster and more economically.

The vehicles that I shall discuss begin with the Scout vehicle (fig. 140). This is a four-stage solid propellent vehicle.

It will be capable of as much as 200 pounds of weight into an orbit at 300 nautical miles altitude above the earth and we can have a vertical probe straight up in the air as high as 12,000 miles with a payload of 50 pounds. The Scout will be used for launching of satellites, for high-altitude probes and for aerodynamic testing of the vehicle.

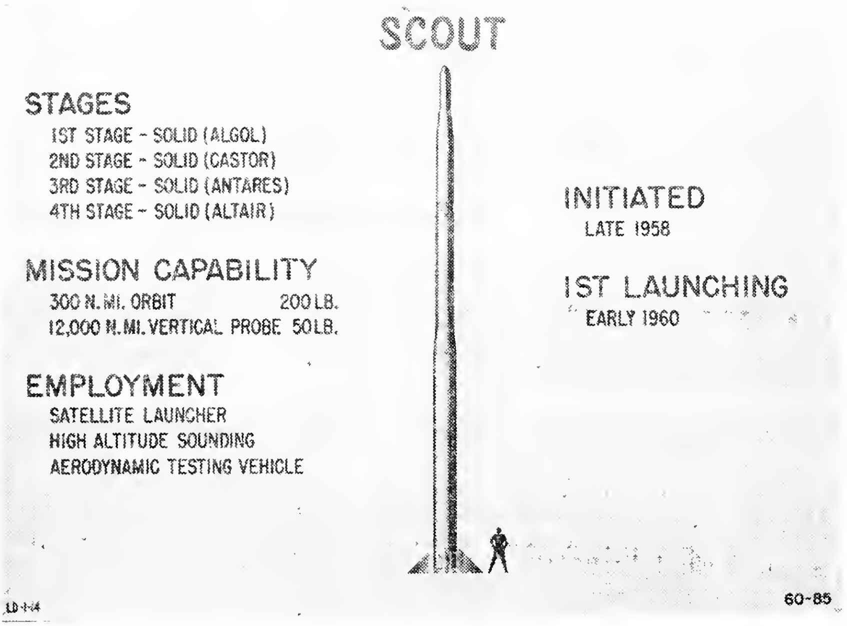

FIGURE 140

For the last mission, what might be done is fire, say, two stages upwards, turn the vehicle through 90 degrees, fire the remaining stages horizontally, and achieve very high speeds in the dense atmosphere. Or, the last two stages might be turned through and shoot 180 degrees, fired downward and achieve very high speeds into even denser atmospheres.

The Scout was initiated late in 1958 and we expect our first launching in early 1960 (fig. 141).

The guidance is all self-contained. Its position in the vehicle is shown here in this cutaway. The individual stages are also shown. The green portion is the solid propellant. The guidance package is relatively inaccurate compared to that contained in future vehicles. No commands from the ground are transmitted to the vehicle after it leaves the launcher.

Mr. McDONOUGH. You mean that the guidance has to be set before you fire for what purpose you want it designed for?

Mr. HYATT. That is right. It has to be programed. Once the vehicle fires and takes off, there is no further guidance command given to it from the ground.

Mr. McDONOUGH. What elevation would you get on the third stage there? Where would you be?

Mr. HYATT. There is a command guidance from this package to the control at this stage, and it gives the signal for this stage to drop off, then it gives the signal for this stage to fire, gives the signal for this stage to drop off, this one to fire, etc. In other words all guidance and control commands are programed into and given by the self-contained guidance package.

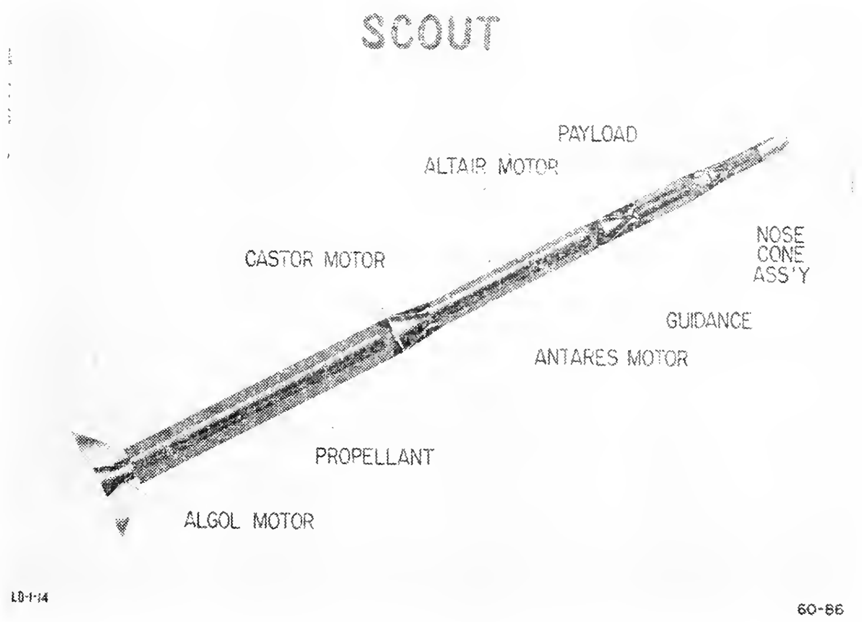

FIGURE 141

Mr. FULTON. Mr. Chairman.

The CHAIRMAN (Mr. Brooks). May I ask you a question? Do you know what thrusts the Russians used in their Pacific shots?

Mr. HYATT. The answer is "I don't know." I have seen a lot of guesses, but I don't know accurately what their thrust was.

The CHAIRMAN. A high range of thrust, though, wasn't it?

Mr. HYATT. You are referring to the ballistic missile shot of some 7,500 miles or so?

The CHAIRMAN. Yes, 7,800 miles.

Mr. HYATT. Well, let me just make a guess. Since we don't know its payload, let us assume that it is of the same order as our own ballistic missiles, then the thrust required should be about the same as our own ballistic missiles.

Mr. FULTON. The same as the Atlas, isn't it?

Mr. HYATT. It could be the same as the Atlas.

The CHAIRMAN. To return to your presentation, why do you have four stages in that relatively small missile?

Mr. HYATT. This is the only way we can achieve the end velocities to put a payload of this kind in orbit, without building an inordinately large vehicle. By staging smallness is achieved. This whole vehicle only weighs 32,000 pounds. If we were to try to do it with a single stage, we may have to go up to a weight of 300,000 pounds and still not be able to do it.

The CHAIRMAN. Mr. Fulton?

Mr. FULTON. May we have the charts put in the record, the drawings, so we can see them?

The CHAIRMAN. Do you have a smaller version of them?

Mr. HYATT. Yes, sir.

The CHAIRMAN. If there is no objection, it is so ordered.

Mr. HYATT. No objection—excuse me, no objection on my part.

The status of Scout is that the development and qualification of the vehicle structure, spin table, and separation techniques are all complete (fig. 142). The development of the rocket motors, the first, second, and fourth stages are all complete and checked out. No. 3 motor was left out because we were having some trouble with it. However, since these charts were prepared we have had four successful firings and now consider that stage out of trouble. So essentially all of our motors are now complete and ready to be put together.

The launcher for the vehicle has been constructed and erected at Wallops Island and the components for the first vehicle, except for the third stage, which still has to be delivered, are now at Langley

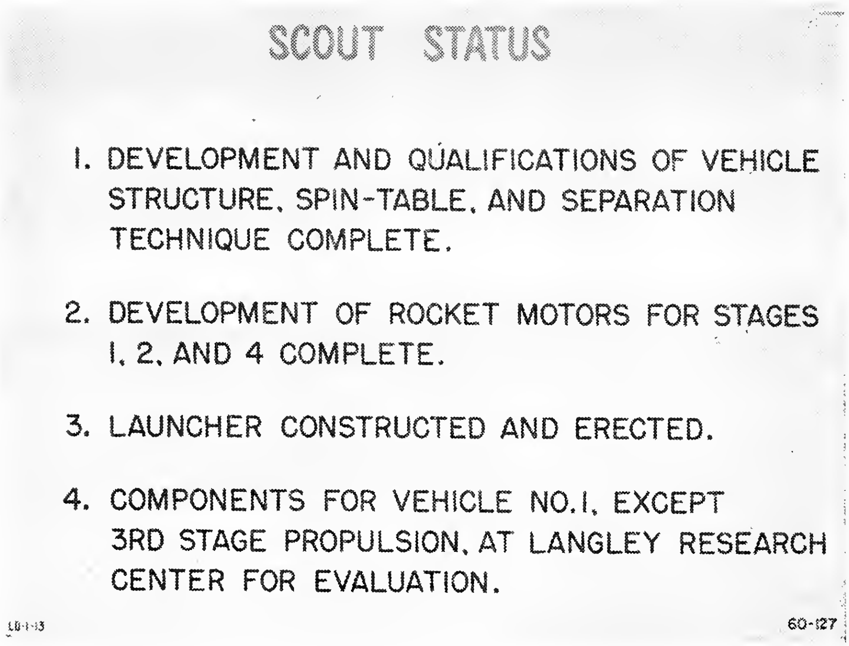

FIGURE 142

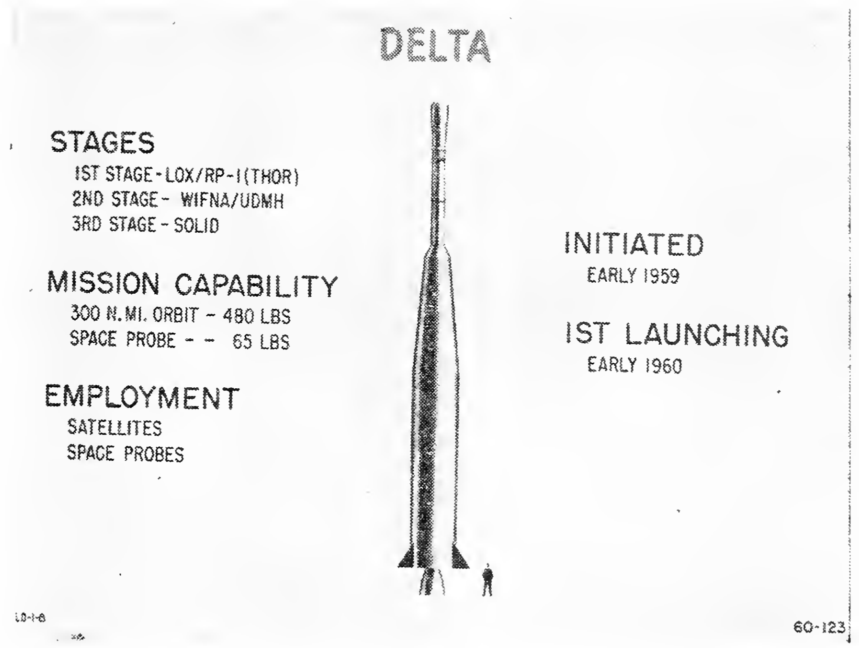

FIGURE 143

Research Center for evaluation. After evaluation all parts will be assembled, checked out, and fired.

The next vehicle is the Delta (fig. 143). It is a three-stage vehicle with the first stage based on the Thor IRBM. The second stage is a slightly modified version of a stage previously used in Vanguard and Thor-Able shots. The fourth stage is the same as the third stage of the Scout. This vehicle will lift as much as 380 pounds into a 300 nautical mile orbit and 150 pounds into an escape trajectory. It will be used for satellite applications and space probes. The development was initiated early in 1959, and our first launching is expected within a couple of months.

We have 12 of these vehicles on order.

I might mention the guidance for the Delta. Ground command guidance is employed for the first two stages. Commands to follow the prescribed trajectory, to cut off first-stage firing, to separate it, to initiate second-stage firing, and to stop it are all given from the ground. From this point internally provided guidance takes over. A coast period follows second stage cutoff. During this time programed internal guidance shapes the trajectory, directs the third stage to spin up, the second stage to separate, and the third stage to fire. No further guidance other than spin stabilization takes place after the third stage is fired.

Mr. FULTON. I have one question.

The CHAIRMAN. Yes, Mr. Fulton.

Mr. FULTON. The question comes up on the transporting of these missiles. I understand that the diameter is too high to get them through the average highway bridge and through the average railway

tunnel. It would cost a billion and a half dollars to change either the highway bridges or railroad tunnels in order to get them from their point of manufacture to the point where they are going to be launched. The question is, do we have to have circular-type configuration on missiles of this size? Couldn't you have them flattened down a little in an elliptic shape or a blunted ellipse? Does it have to be always a round configuration?

Mr. HYATT. The round configuration has many advantages.

Mr. FULTON. But not $1½ billion worth, does it?

Mr. HYATT. Well, we don't expect to change all the railroads. We expect to find some other way of transporting large diameter vehicles, for example, by water means, when they become so large that they cannot be transported by any other means, that is.

Mr. FULTON. Pennsylvania is already talking about our State being charged $25 million for changing bridges or tunnels for you people.

Mr. MCDONOUGH. It could be shipped in sections, couldn't it?

Mr. HYATT. It is the diameter he is referring to.

Mr. FULTON. It is the diameter. I am saying, "why not an ellipse"?

Mr. MILLER. What is the diameter of this?

Mr. HYATT. I don't think Mr. Fulton is referring to these. This particular one is only 90 inches.

Mr. MILLER. You have no trouble with that.

Mr. FULTON. I am referring to the big ones. Some of them are pretty fair. We have 16-foot clearances, you see, on most bridges.

Mr. HYATT. That is right.

Mr. FULTON. Fourteen feet.

Mr. HYATT. Actually, our largest missile today is some 10 feet in diameter, but we are planning to build some as large as 20 feet in diameter.

Mr. FULTON. On the new highway program there have been some bridge tunnels 14 feet high. I am wondering if you people doing this testing have tried flattening them into an ellipse.

Mr. HYATT. I have not studied that point, but I would hazard a rather firm guess that it would be a serious penalty for us to design them that way.

Mr. FULTON. Put a statement in, will you?

Mr. MILLER. Jim, if you do that, wouldn't you be robbing Peter to pay Paul? If these things are 20 feet in diameter, you couldn't take them on the highways anyway, and if you made them into an ellipse you would be narrowing one diameter and lengthening the others.

Mr. FULTON. Yes.

Mr. HYATT. Yes. There are many technical reasons, too, for not using elliptical shapes. The tanks are internally pressurized. The circular shape is best to resist such pressures in a hoop tension manner. But if you had something other than a circle, then the internal pressure would want to push that shape out into a circle. Therefore increased strength in bending would have to be provided and that means added weight, and so on.

Mr. MILLER. Wouldn't you practically build these big ones on the ground?

Mr. MCDONOUGH. At the point of launch.

Mr. HYATT. We expect to build them at some factory and then ship them to the point of launch.

The CHAIRMAN. Do you take into consideration the condition of the roads and bridges when you let a contract?

Mr. HYATT. Yes, sir.

The CHAIRMAN. You do?

Mr. HYATT. The contractor is required to propose how he would ship the constructed vehicle from his plant to the point of launching.

The CHAIRMAN. So if the plant were Pennsylvania and the bridges were low there, you would award it, maybe, to West Virginia, instead, if the bridges there were all right?

Mr. MOELLER. Or Ohio.

Mr. FULTON. Perish the thought. [Laughter.]

Mr. MILLER. Dr. Hechler looked up. It is the first time he has shown any——

Mr. FULTON. There is a point here where the cost proposed for railroads or for highway bridge changeovers is going to be a billion and a half dollars for the next generation missiles. That is the most recent estimates we have. So it is no small question. It isn't a question of just——

Mr. MILLER. It is a big question.

Mr. FULTON. It may isolate California from the rest of the country. [Laughter.]

Mr. MOELLER. Is air transportation forbidden here?

Mr. HYATT. No, sir; it is not. There is a possibility of air transportation, but not necessarily with an airplane-type vehicle.

The CHAIRMAN. I think the whole highway problem is a big one. Sometimes I think it is a big mess. But I think we had better get back to the space program.

Mr. HYATT. All right, sir.

Now, the status of the Delta vehicle (fig. 144, p. 732) is that the first, second, and third stages have been delivered to the Atlantic Missile Range for the first vehicle. The complete third stage has been successfully flight-tested in two separate firings, and the hardware for the remaining vehicles is on schedule. This vehicle is progressing nicely and we are quite satisfied with its progress.

The Centaur vehicle is shown on the next chart (fig. 145, p. 732). You will recall that the first stage is a modified Atlas and the second stage is one that uses high-energy propellants, liquid oxygen and liquid hydrogen.

I would like to just mention that liquid oxygen has a liquid temperature of minue 290° F. At some value higher than that it is a gas. Liquid hydrogen has a liquid temperature of minus 422° F. Also liquid hydrogen is about one-sixteenth as heavy as liquid oxygen, so those two characteristics present us new problems.

Because of its high-energy upper stage, the Centaur has a capability of putting as much as 8,500 sounds into a 300-nautical-mile orbit and as much as 450 pounds into a planetary probe. The vehicle will be used for lunar and planetary explorations and also has the possibility of a 24-hour communications satellite, plus numerous other uses.

The Centaur vehicle (fig. 146, p. 733) was initiated by the Department of Defense in late 1958. It was turned over to NASA for development on July 1, 1959. We expect the first launching in mid-1961.

I have a cutaway of the Centaur (fig. 147, p. 733) that I thought you might like to see. This is the first stage with its three engines. At

DELTA STATUS

1. FIRST, SECOND & THIRD STAGES DELIVERED TO ATLANTIC MISSILE RANGE FOR FIRST VEHICLE.

2. COMPLETE THIRD STAGE SUCCESSFULLY FLIGHT TESTED IN TWO SEPARATE FIRINGS.

3. HARDWARE FOR REMAINING VEHICLES IS ON SCHEDULE.

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FIGURE 144

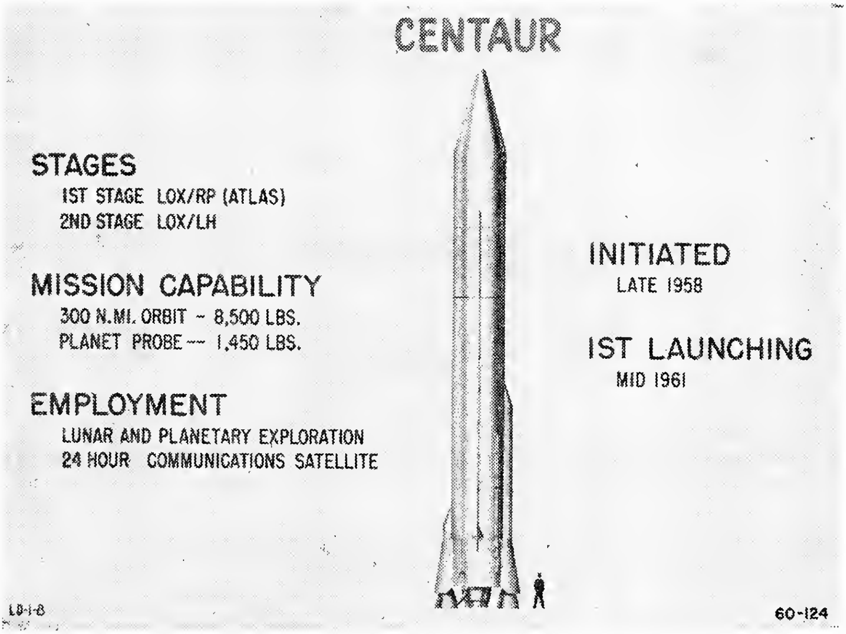

FIGURE 145

CENTAUR STATUS

1. PROGRAM INITIATED	NOV 1958
2. 1ST FULL DURATION ENGINE FIRING	NOV 1959
3. 1ST HYDOGEN TANK TEST	DEC 1959
4. SCHEDULED CAPTIVE TESTS	NOV 1960
5. SCHEDULED FLIGHT TESTS	1961

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FIGURE 146

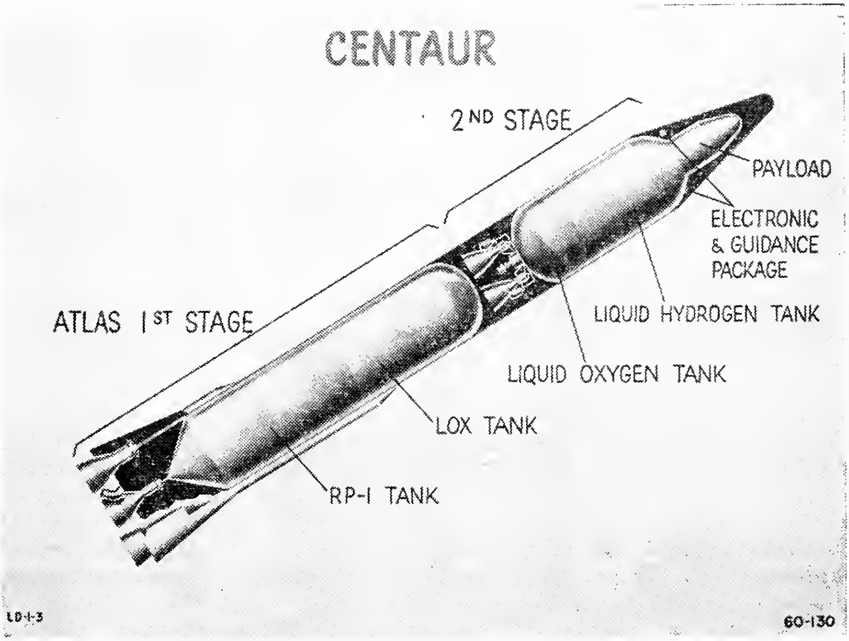

FIGURE 147

some time after the initial takeoff the two outer engines drop off. The center engine continues to burn until the fuel is used up in this tank, then the tank drops off and the second stage fires. It has two engines. If you will notice this shading you can see the lower tank which contains the liquid oxygen. In the tank from here to the top is liquid hydrogen.

You will notice the difference in the volume because of the lightness of the fuel. The payload is at the top. The second stage will have the capability of firing in space, stopping, coasting for a while and then firing again. Also, the guidance in this vehicle is all inertial. There are no commands from the ground. The mission is programed into the guidance mechanism and it gives the instructions to all portions of the vehicle and for all the sequential operations.

The CHAIRMAN. What is that mark on that first tank, midway?

Mr. HYATT. That is the——

The CHAIRMAN. No, midway.

Mr. HYATT. This is the tank for jet fuel, and this is the liquid oxygen tank.

Mr. FULTON. Could you narrow the diameter by lengthening the vehicle?

Mr. HYATT. Yes, sir, we could, but we get into trouble because a long structure becomes too flexible and could be unstable.

The CHAIRMAN. It also wrinkles, too, doesn't it?

Mr. HYATT. Yes, sir; it could. Nearly every way you face there is some sort of technical obstacle. The state of this program is that we have had the first full duration engine firing November of last year. A flight-type hydrogen tank was tested in December of last year. The first captive test of the second stage is scheduled in November 1960, and the first flight is expected some time in 1961.

Mr. McDONOUGH. Do we have any knowledge of similar vehicles that Russia has compared to this?

Mr. HYATT. No, sir; we do not. The only thing I have ever seen was a statement by one of their top people in answer to a question by one of our people. The Russian's answer was "Why use hydrogen?"

Mr. BASS. What will be the thrust of this Centaur, the booster, the most powerful?

Mr. HYATT. The thrust of the first stage is the same as that of an Atlas. The second stage has two engines, each giving 15,000 pounds of thrust.

The next chart shows the Saturn (fig. 148), which I only present for completeness. You have already been briefed on this vehicle by Dr. von Braun. The first stage propulsion consists of a cluster of eight engines, and the second stage will have a cluster of four engines. Propellants for the first stages are RP or kerosene and liquid oxygen while the second stage will have as propellants liquid oxygen and liquid hydrogen. The second-stage engines will be uprated Centaur engines to 20,000 pounds thrust. A third stage very similiar to Centaur will also be used.

Now, this vehicle can lift as much as 28,500 pounds into a 300-nautical-mile orbit. For a mission either to the Moon or probe into deep space, a payload of some 9,000 pounds can be accelerated to escape velocity. This vehicle will be used for lunar and space probes.

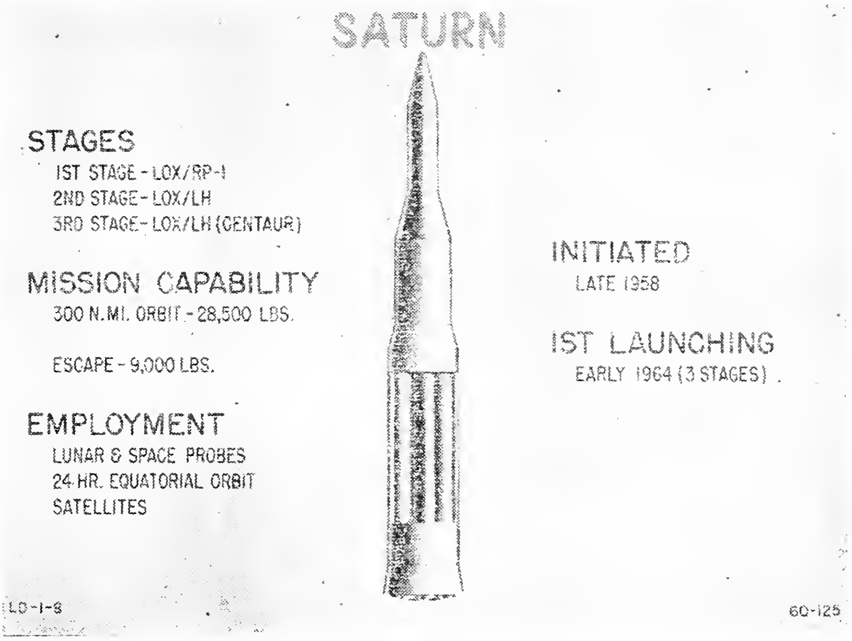

FIGURE 148

It can be used for a 24-hour equatorial orbit communications satellite, and other kinds of satellites. The program was initiated in late 1958. The first launching of a three-stage vehicle that might be considered as operational, that is, the 11th vehicle of a vehicle development program, is expected in early 1964.

Mr. FULTON. Mr. Chairman.

The CHAIRMAN. Mr. Fulton.

Mr. FULTON. You are going to launch that from Cape Canaveral and you are manufacturing it over in Redstone Arsenal, Ala. How are you going to get that behemoth to the Cape?

Mr. HYATT. By water. There is a specially developed and equipped barge being constructed. The first stage will be transported on a special truck to the barge dock on the Tennessee River, then the barge will be towed down the Tennessee and Ohio, down the Mississippi to the gulf, around the tip of Florida and up to Canaveral.

The CHAIRMAN. Down the intracoastal canal into Florida.

Mr. HYATT. Now I'll review quickly the developmental status of the Saturn. The first stage is under construction, much of it has been built. The test facility at Huntsville is practically complete. We are constructing a launch facility at Canaveral, and just within the last month we have requested industry to submit proposals for the construction of the second stage.

The last launching vehicle I wish to discuss is the Nova (fig. 149, p. 736). I must point out it is only a concept, that we are not yet developing the vehicle itself. The only portion of it that is under development is the 1½-million-pound-thrust engine, which might be used in clusters to power the first and second stages.

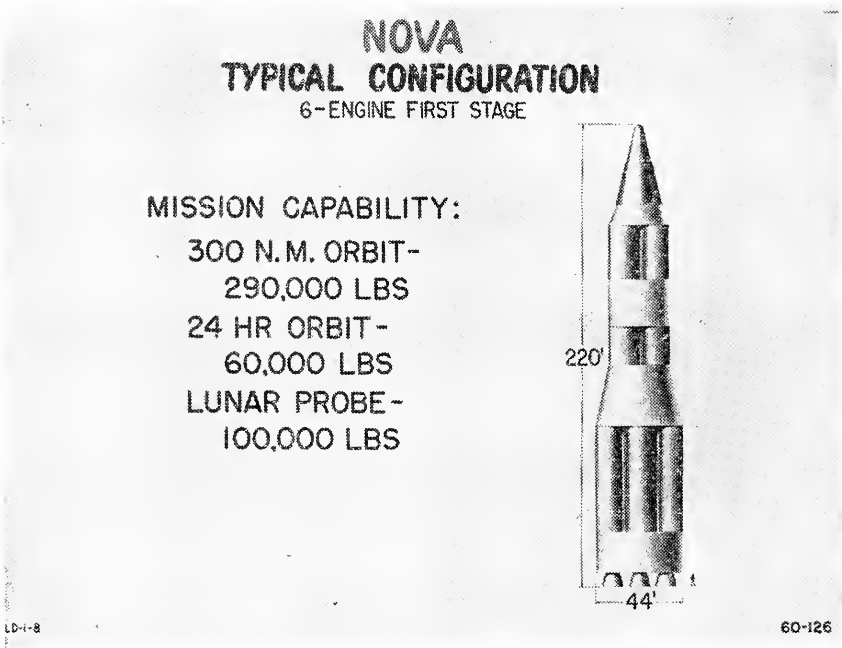

FIGURE 149

If we had a cluster of six 1½-million-pound-thrust engines in the first stage, two in the second, one in the third, we could have the load-carrying capability shown: Some 290,000 pounds into a 300-mile orbit; into a 24-hour orbit some 60,000 pounds, and a load to the Moon of some 100,000 pounds.

Now, this is a——

The CHAIRMAN. That is just the bell. Go ahead.

Mr. HYATT. Now——

Mr. MCDONOUGH. Mr. Chairman.

The CHAIRMAN. Mr. McDonough.

Mr. MCDONOUGH. If this were operative and you did put into a 300-nautical-mile orbit 290,000 pounds, what would be the life of the 290,000 pounds in orbit?

Mr. HYATT. In a 300-mile orbit, it should stay there for a good many years.

Mr. MCDONOUGH. And when it had lost its orbital velocity, when it had lost that and started coming back in, that wouldn't disintegrate coming through, would it?

Mr. HYATT. That is right. It would not all be consumed coming through the atmosphere.

Mr. MCDONOUGH. Left over to land someplace?

Mr. HYATT. Land someplace; yes, sir.

Mr. MCDONOUGH. And you couldn't control where it would land?

Mr. HYATT. Well, you could build into this vehicle a reentry capability. There is enough weight to do that. In that case its landing point could be controlled.

Mr. McDonough. You could control where it lands or you could disintegrate it; one or the other?

Mr. Hyatt. You could disintegrate it.

The Chairman. You haven't the capability built in now to reenter; you would have to build it in?

Mr. Hyatt. You would have to build it in. You would have to construct the reentry vehicle so that it would have wings or other means of lift to control and land at a predesignated spot.

Mr. McDonough. Do we have the capability of putting into a 300-nautical-mile orbit a quantity in excess of an amount that would disintegrate for reentry purposes?

Mr. Hyatt. I am not sure that I understand your question, but if, for example, a steel ball one foot in diameter was in a circular orbit and it started coming back into the atmosphere, I don't believe it would burn up entirely, that the outside surface would melt some, but there would still be a good portion of it left to impact at some point on the earth.

Mr. McDonough. We haven't got the capability of putting a ton up, have we?

Mr. Hyatt. At this time, no.

Mr. McDonough. No.

Mr. Hyatt. Well, I will take that back. Mr. Low, in his next presentation for a very low orbit——

Mr. McDonough. I don't want to get into anything classified. Is this the first time this has been revealed, this information that you are giving us now?

Mr. Hyatt. I am not sure that Saturn has been explained before. Some of this was presented——

Mr. McDonough. I am just wondering; is there any security officer around here? Are we asking for more than——

Mr. Hyatt. As far as I can judge, I will not reveal anything that is classified.

The Chairman. So you are protecting yourself, then. All right.

Mr. Fulton. Nova could be used for a space platform, then, or possibly as a launching pad for other vehicles? We wouldn't have to take the vehicles off the ground if we could put them up 300 miles——

Mr. Hyatt. Yes, sir; that is certainly——

Mr. Fulton (continuing). And had a method of getting them up there, and a much more accurate method of launch?

Mr. McDonough. You mean automatically, not manned launchings?

Mr. Hyatt. Launched from a space platform.

Mr. Fulton. Launched from a space platform, manned or otherwise?

Mr. Hyatt. Yes.

Mr. Riehlman. Isn't that more difficult than launching from the Earth, in order to hit a target?

Mr. Hyatt. Right now, of course, we can't do it.

Mr. Riehlman. I mean in time.

Mr. Hyatt. It may actually offer advantages to launch from an orbit around the Earth. In fact, there have been studies made of launching vehicles from the ground, have them assembled in an orbit

around the Earth and then launch your operation further into space from that orbit.

Mr. FULTON. Did I understand you to intimate we could at present put a ton in orbit? If so, I am pleasantly pleased and surprised.

Mr. HYATT. Well, the Mercury program—mind you, I made the comparison of all the vehicles I discussed, for a 300 miles altitude orbit, 300 miles above the Earth. Into a low orbit, 100 miles altitude or so, the Atlas in the Mercury program will put up as much as a ton?

The next chart (fig. 150) shows all the vehicles we are now using. Some of these will definitely be phased out. I will just flip the

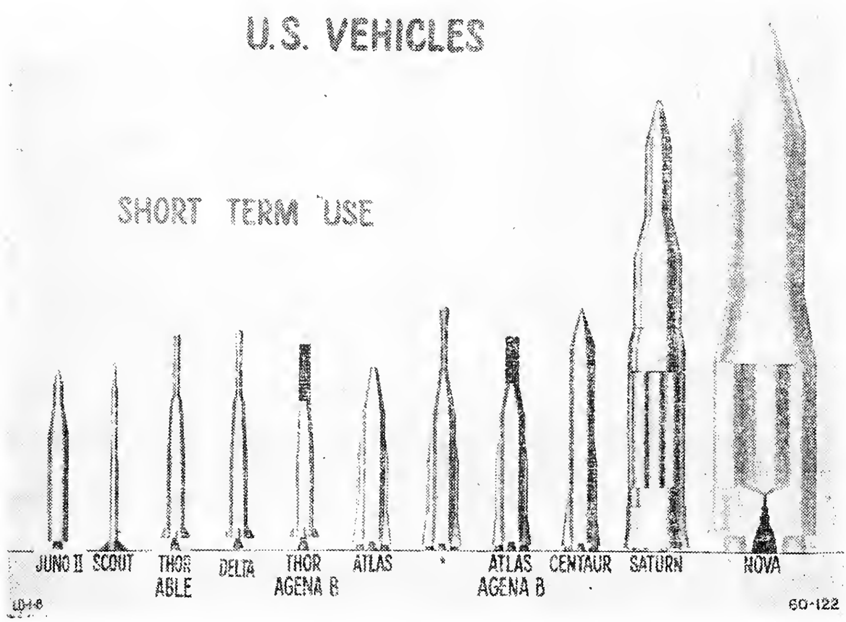

FIGURE 150

transparent sheet and show what we hope to have left (fig. 151). Even some of these, for example, this one might be eliminated. And of course the Nova is just a plan now; it is not yet under development. So we wind up with the Scout, the Atlas that is used in Project Mercury, the Atlas Agena, Centaur, and Saturn as our stable of vehicles for space exploration.

The CHAIRMAN. You will have five of them?

Mr. HYATT. If we eliminate this one it is 1, 2, 3, 4, 5.

Finally, here is a quick résumé of the budget requests for fiscal 1960 and 1961 (fig. 152).

The CHAIRMAN. I hope you chairman of the subcommittees watch this very closely.

Mr. SISK. We are watching, Mr. Chairman.

The CHAIRMAN. All right.

Keep an eagle eye open.

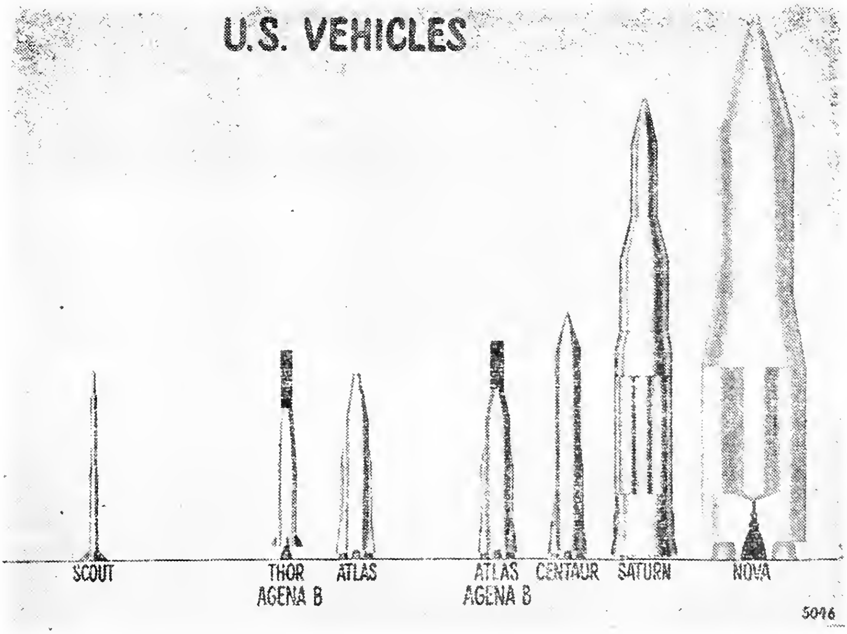

FIGURE 151

VEHICLE DEVELOPMENT COSTS

VEHICLE		COST BY FISCAL YEAR IN MILLIONS 1960		1961	
SCOUT		2.8		0	
DELTA		13.3		12.5	
CENTAUR		37.0		47.0	
SATURN	R&D CONTRACTS	33.9	70.0	146.0	230.0
	OTHER COSTS	36.1		84.0	

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FIGURE 152

Mr. HYATT. The Scout, we hope to complete development this year. The Delta, we have requested $13.3 million in 1960, an additional $12.5 million in 1961. For the Centaur vehicle, $37 million in 1960 and $47 million in 1961.

The Saturn, this figure was $70 million, however we have added another $1½ million in the last month, so this makes it $71.5 here and in 1961 we are asking $230 million.

Mr. McDONOUGH. Where is Vega?

Mr. HYATT. Vega was canceled.

Mr. McDONOUGH. How far did we get along with Vega?

Mr. HYATT. We got to the point where we had some parts of the stage constructed, we had the engine pretty much completed and testing, and a good bit of the engineering for the entire vehicle was done.

Mr. McDONOUGH. The engine is not scrapped? The engine can be used?

Mr. HYATT. It could be used, if we had a place for it.

Mr. McDONOUGH. What is the reason for scrapping Vega?

Mr. HYATT. The principal reason was to reduce the number of vehicles in our national vehicle program and to save money, ultimately.

Mr. McDONOUGH. We didn't put anything in its place? We just continued with the program and dropped that out?

Mr. HYATT. The Atlas Agena B will replace it.

Sir, this completes my statement.

The CHAIRMAN. Fine, we thank you very much, Mr. Hyatt.

Now, who do we have next?

Mr. HORNER. George Low will talk about project Mercury right now. He has a prepared statement which I believe has been given to the committee and he is going to talk from charts.

The CHAIRMAN. Mr. Low, we want to thank you for coming here. We have put you off a number of times, and you have been very patient, the delay is not due to any lack in your presentation, however. You are a victim of circumstances. We couldn't use you sooner. We thank you for coming here.

Mr. LOW. With your permission, Mr. Chairman, I will use a number of charts in my presentation.

The CHAIRMAN. Fine.

Mr. HORNER. Mr. Low also has as a part of his presentation a movie, Mr. Chairman. Some of the committee members might want to avail themselves of the opportunity——

The CHAIRMAN. It is not a classified movie?

Mr. HORNER. No, sir.

Mr. McDONOUGH. There isn't anything about Mercury that is classified, is there?

Mr. HORNER. There are some elements of the Mercury program that are classified for the security of the project; yes, sir.

The CHAIRMAN. But he is not going to give them to us this afternoon?

Mr. HORNER. No, sir.

STATEMENT OF GEORGE M. LOW, CHIEF, MANNED SPACE FLIGHT PROGRAMS, NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

Mr. Low. Mr. Chairman and members of the committee, the subject of my discussion today is Project Mercury.

As you may recall from my presentation to this committee last year, Project Mercury represents this Nation's effort to launch and recover a manned satellite. The program's primary objective is to study man's capabilities in a space environment.

The project was conceived, and is being carried out, in a manner that will attempt to achieve manned orbital flight at an early date.

Let me now briefly review, with a few charts, some of the basic principles involved in this project.

My first chart shows the Mercury capsule system (fig. 153). When this satellite is launched into orbit it sits on top of an Atlas booster, with the small end pointed up. The capsule proper, or the satellite in which the man rides, is the large cone-shaped object. The capsule system also includes a package of small solid propellent rockets, used first to separate the capsule from its launching vehicle, and later on to return the capsule back from its orbit.

On top of the capsule is a tower-like structure—let me take one of the models here—and this tower holds another solid propellent rocket which is used to carry the capsule away from the booster, should the booster malfunction during the early stages of flight.

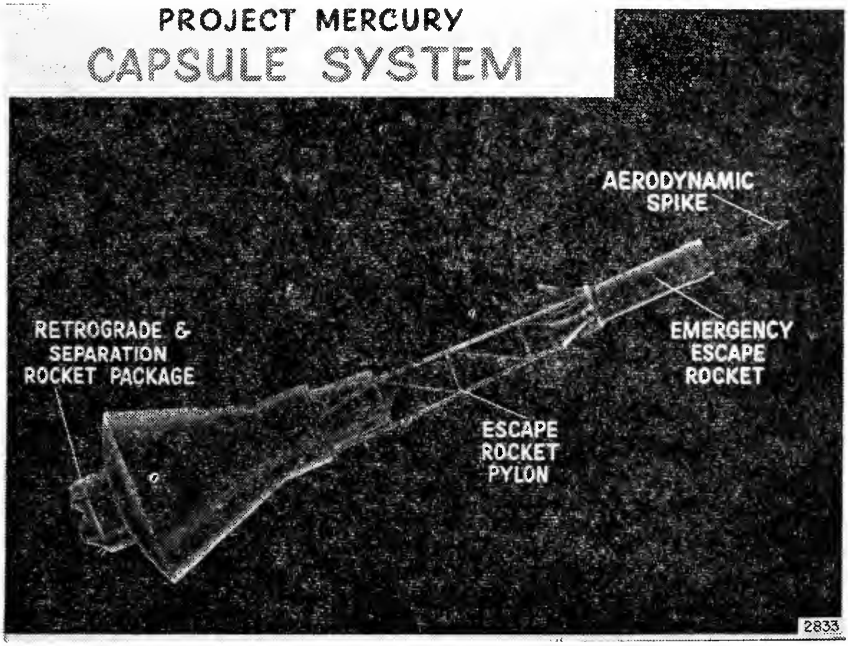

FIGURE 153

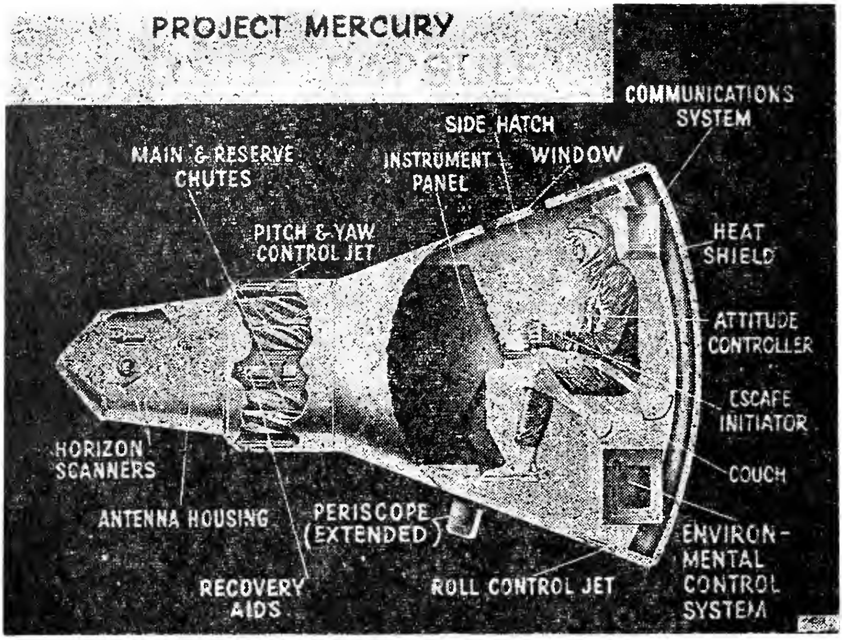

FIGURE 154

Now, the next chart (fig. 154) shows a cutaway view of the same capsule revealing some of the engineering details.

The shape of the capsule, itself, was determined from aerodynamic considerations during the capsule's reentry into the atmosphere. When the capsule returns to the atmosphere it will fly with the large blunt end pointed forward. The heat of reentry will then be dissipated by a plastic heat shield.

Within this pressure-tight capsule the pilot is supported in a form-fitting couch. When the capsule reenters the atmosphere the astronaut will be pressed back into the couch with eight times the force of gravity. Centrifuge tests have demonstrated that a man supported in such a couch can withstand considerably more than the number of g's that he will encounter in the Mercury mission.

The atmosphere within the capsule is controlled and kept within prescribed limits by an environmental control system. There is a communications system which transmits data to ground stations, and also allows the astronaut to talk to ground stations periodically.

While in orbit the capsule's attitude will be controlled. It will be stabilized, so that it is oriented in a prescribed direction. This will be done through infrared horizon scanners, which sense the capsule's attitude, and with small hydrogen peroxide jets which then can orient the capsule in the proper direction.

The CHAIRMAN. That is automatic, is it?

Mr. LOW. This is normally done automatically. But the pilot also has a manual attitude controller; by observing his instruments and by looking at the Earth through a periscope and then by using the manual attitude controller, he, himself, can also change the capsule's attitude.

In order to bring the capsule back down to earth the small solid propellent rockets housed at the blunt end of the capsule, and not shown in this chart, will be fired. These slow the capsule down by 350 miles an hour. This is just enough so that the Earth's gravity will slowly reassert itself and pull the capsule down toward the Earth atmosphere.

The capsule is then slowed down, by the drag of the air through which it flies, from almost its orbital speed of 17,500 miles per hour to a low speed of about 200 miles an hour. Then, at an altitude of 10,000 feet, a large cargo parachute is deployed. This parachute, and a second parachute for emergency purposes, is housed in the small end of the capsule. The capsule is then lowered by parachute to the Atlantic Ocean where it will be picked up by recovery ships.

Pictorially, this sketch indicates that the capsule is a relatively simple device; but such is not the case. It has been a major engineering task to design a capsule so that it can withstand the forces and the heating of atmospheric reentry, and yet is light enough so that it can be boosted into orbit. The design of subsystems that are highly reliable, and yet small enough to fit within the 6-foot diameter capsule has stretched the existing state of the art.

Perhaps the complexity of this device can best be illustrated by the fact that there are 7 miles of electrical wiring interwoven within the capsule to activate the various electronic systems and rockets, and the many other devices.

Now, there has been a great deal of discussion as to how much a pilot should be allowed to do in a space mission. We who are associated with Project Mercury believe that the pilot's role should be a very active one. Just how much he will be able to do can best be illustrated with a picture of the capsule's instrument panel (fig. 155, p. 744), as shown on the next chart.

The key to his entire participation is the sequence control panel.

On this panel there are a series of lights, switches, and buttons. The lights will come on green if any of a number of functions that the capsule systems are supposed to perform are performed automatically. However, if a function does not take place at the proper time, a red light will come on.

The pilot then has an independent circuit, activated by a switch that he can push to perform this function manually.

Mr. McDonough. When the red light appears, does it indicate which section is not operating properly?

Mr. Low. Yes, it does. For instance, illustrated here is a red light on for the retrorockets, the rockets that are supposed to be fired to bring the capsule out of orbit. If this light comes in this means that the retrorockets have not been fired automatically at the proper time. By pushing the button next to this light the pilot can light off the rockets himself to get himself out of orbit; and he can perform a dozen or so other functions.

The Chairman. What is the difference between retrorocket and the ground rocket? The ground rockets bring him down to 350 miles an hour?

Mr. Low. No, sir. The retrorockets are the ones that slow him down by 350 miles an hour. In orbit he is moving at about 17,500 miles an hour. These rockets slow him down by only 350 miles an

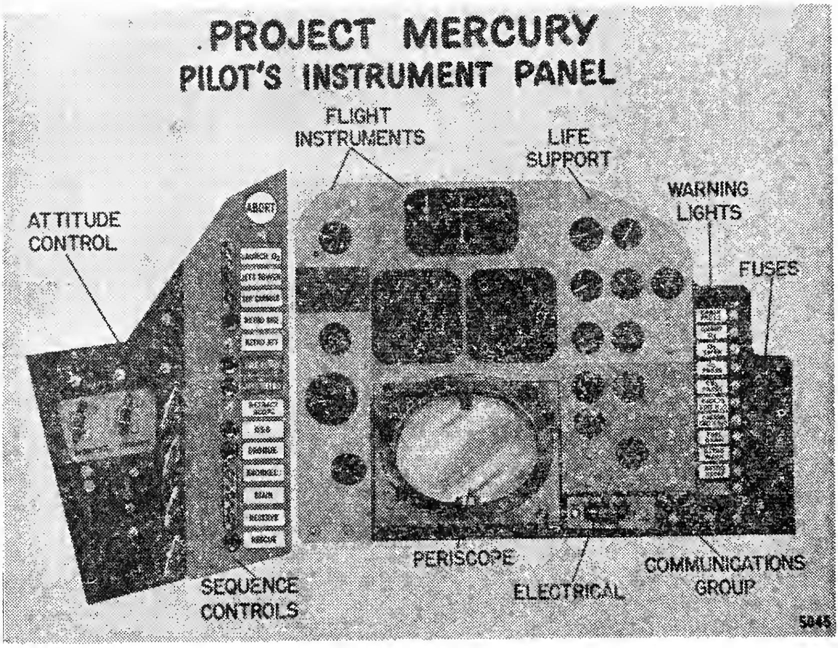

FIGURE 155

hour, so that his speed will still be somewhat more than 17,000 miles an hour. But the speed is just low enough, so that the Earth's gravity will pull the capsule back.

The CHAIRMAN. He is going 17,500 miles an hour and only reduces 350, and you get him out of orbit?

Mr. LOW. That is enough so that the gravity of the Earth will slowly pull the capsule back down out of orbit.

The CHAIRMAN. They don't have any other rockets to use near the ground?

Mr. LOW. No, sir.

On the lefthand panel the pilot has a series of controls that allow him to lock out the automatic control system and activate his manual control stick. Once he has locked out these automatic controls and has activated the manual ones, then with the flight instruments, and with a periscope through which he can see the ground, he can, himself, orient the capsule in any direction he desires.

Also on the lefthand panel is a valve to decompress the capsule and vent it to the outside vacuum. This he would use in case there should be a fire within the capsule or a buildup of toxic gases; in other words, it is his fire extinguisher. By venting the capsule to the outside atmosphere he would immediately put out the fire; he could then recompress the capsule by pulling another handle.

The CHAIRMAN. What do you mean by venting it?

Mr. LOW. To open the capsule to the outside vacuum. The pilot would open a small valve and open the capsule to the outside vacuum.

The CHAIRMAN. That would leave space inside.

Mr. Low. Of course, the pilot is still in his pressure suit; he wears a special pressure suit so that close to his body there will still be sufficient pressure to allow him to live. But the rest of the cabin will be evacuated, if he pulls this.

Mr. McDonough. He can shut that off?

Mr. Low. He can then shut that off and pull a second handle to build up the pressure within the capsule again.

The instruments on the right-hand side of the panel have to do with his life support system. The various gages record the pressures, temperatures, and the gas composition within the capsule. If, for instance, the carbon dioxide builds up to too high a level, the astronaut will note this on one of the gages and will be able to purge the capsule with more oxygen. On another panel are gages to tell him how the electrical system is functioning, and the various dials for the communication system. A series of warning lights are provided to indicate the malfunctioning of various systems.

By looking at this panel we can see that the pilot's participation in the Mercury mission will be a very active one.

Now, a project as complex as Mercury could not be carried out without a very extensive research and development program. At the end of my presentation I will show a film that will show what we have accomplished in this research and development program during the past year.

But before I show the film I would like to briefly run through a few more charts to show the flights that we expect to take place during the next year or two.

Mr. McDonough. Mr. Low, has the condition that you have described been simulated with a man in the capsule? For instance, your opening the vent and closing the vent, has that been simulated?

Mr. Low. It has not yet been completely simulated within a capsule. We have checked out his environmental control system in a vacuum tank. We do not yet have a capsule available to check the pilot within this capsule with all the systems. But this is planned to be done in the future.

The Chairman. Suppose a short circuit occurs within one of those 7 miles of wire, would the astronaut be able to move about enough to correct the short circuit?

Mr. Low. Yes. He can reach his entire instrument panel. He would not be able to reach, for example, behind the instrument panel. But he does have a number of fuses on the panel, here, and if a short circuit, for example, should blow a fuse, he would be able to change that fuse.

The Chairman. Put in a new fuse?

Mr. Low. That is right.

The Chairman. But that is as much as he could do in the way of repairs?

Mr. Low. That is right.

The Chairman. Pressing a button is about all he could do?

Mr. Low. Yes.

But I should mention, perhaps, that almost each one of the systems and subsystems within the capsule is duplicated. There are two radio transmitters, two receivers, there are double systems. So that even if one goes out he would still be able to get along on the secondary system.

Mr. BASS. How does he breathe? I gather he does not breathe the air in the capsule?

Mr. LOW. Let me go back to the chart showing the capsule again. You will notice that the pilot is within a pressure suit. Now, the oxygen from the environmental control system can be circulated through his suit and he would then be breathing within the suit only; or he has the option of opening the face plate on the suit in which case he would breathe the oxygen within the capsule.

Mr. FULTON. Of course there is a question that always pops into your mind. He isn't a Senator who can stay on the floor for 20 hours. Where is the bathroom in the capsule? Is there one? [Laughter.]

Mr. LOW. No, there is not.

The CHAIRMAN. Better take that up in executive session. [Laughter.]

Mr. FULTON. I am worried about the guy.

Mr. MCDONOUGH. What is the duration of his flight?

Mr. LOW. The flight will be 4½ hours.

Mr. MCDONOUGH. Four and a half hours.

Mr. LOW. He will be on a low residue diet for some 3 days before the flight.

Mr. MCDONOUGH. Going back to the period where he uses the retrorocket to reduce his speed from 17,500 to 350——

Mr. LOW. He reduces the speed with the retrorockets only from 17,500 to 17,150, only by 350 miles an hour. Then as he flies back through the air, the drag of the air through which he flies will slow him down to 200 miles an hour.

Mr. MCDONOUGH. Then the only other brake he has is a parachute?

Mr. LOW. A parachute that comes out only when he is flying at about 200 miles an hour.

Mr. MCDONOUGH. Has that been simulated?

Mr. LOW. Yes. As you will see in the motion picture we have run through a very extensive series of parachute tests where we have dropped full-scale capsules out of planes time and again to check out the parachute systems.

Mr. MCDONOUGH. At 200 miles an hour?

Mr. LOW. Yes, sir; this will be shown in the picture.

The CHAIRMAN. Suppose the rocket goes up and gets into an orbit of 18,000 miles an hour. I notice the ICBM's have a speed of 18,000 miles an hour. How would you get him out of orbit then?

Mr. LOW. By firing these rockets at the proper place and the proper time in orbit, particularly by firing them at the apogee or the highest point, one could still get him out of orbit even if the highest speed in the orbit is 18,000 miles an hour.

Mr. MCDONOUGH. Another question, Mr. Chairman.

You say 4½ hours is the duration of the flight. Can he permit a longer duration than that? Can he fly for a longer period than that, if he wants to?

Mr. LOW. All systems within the capsule are designed for longer periods of time, but our plan now is that, in the initial stages of flight, we will allow him only to go up for 4½ hours, which amounts to three orbits. The recovery ships will be deployed for this three orbit mission. If he stayed up longer then he might come down in a landing area that is not covered by ships for example.

Mr. McDonough. This is ground control?

Mr. Low. That is right.

Mr. McDonough. He comes down under a ground control station?

Mr. Low. He comes down either under ground command or under his own command; both are possible. In case the ground command should fail, he still could get himself out of orbit.

Mr. Fulton. Mr. Chairman.

The Chairman. Mr. Fulton.

Mr. Fulton. On the first space flight, what is the altitude, how far will he go and how long will he be up?

Mr. Low. Mr. Fulton, with my next two or three charts I am going to cover all of these points, I think, in some detail.

Mr. Fulton. One other thing. There are always rumors getting started. I read an article that a woman may be first in space. Is that wrong? Are you training or recruiting any women for this?

Mr. Low. I can only speak for this Nation's effort. [Laughter.] We have only the seven astronauts who were introduced to you gentlemen last spring, I believe. We have no additional ones.

Mr. Fulton. I saw a very comely young lady on the front page of one of the large circulation magazines in the United States. It stated that she was being considered.

Mr. McDonough. That was for a newspaper magazine story.

Mr. Fulton. Is it true or not?

Mr. Low. She is not being considered by us.

The Chairman. The rumor I heard was that a Congressman was going up.

Mr. Moeller. I heard he was going to be the chairman of our committee.

Mr. Fulton. I volunteered 2 years ago and was rejected. [Laughter.]

Mr. Low. During this calendar year we will start a very important series of qualification flights using the Redstone booster.

The Redstone booster is the last one of the three vehicles shown by these models (fig. 156, p. 748).

In these flights the Redstone will accelerate the capsule to a speed of 4,000 miles an hour. It will carry it to an altitude of 125 miles, and to a distance of 200 miles from Cape Canaveral. During the launch, 6½ g's will be sustained 11 g's during reentry, and there will be 5½ minutes of weightless flight along this trajectory.

Now, our plans are to initially fly an instrumented capsule along this type of a trajectory. Later on we will fly chimpanzees along a similar trajectory. And, finally, when we are convinced that all the systems are sufficiently reliable we plan to have manned ballistic flights using this Redstone vehicle.

In these flights man will be subjected to essentially the same forces during exit and reentry as he will be in his orbital flight, and the 5½ minutes of weightless flight which is better than five times more than had heretofore been possible in airplane flights.

We believe that these flights will tell us a lot concerning the astronaut's capabilities in space flight before we finally send them on an orbital mission.

Following the Redstone flights there will be a series of ballistic flights using the Atlas booster (fig. 157, p. 748).

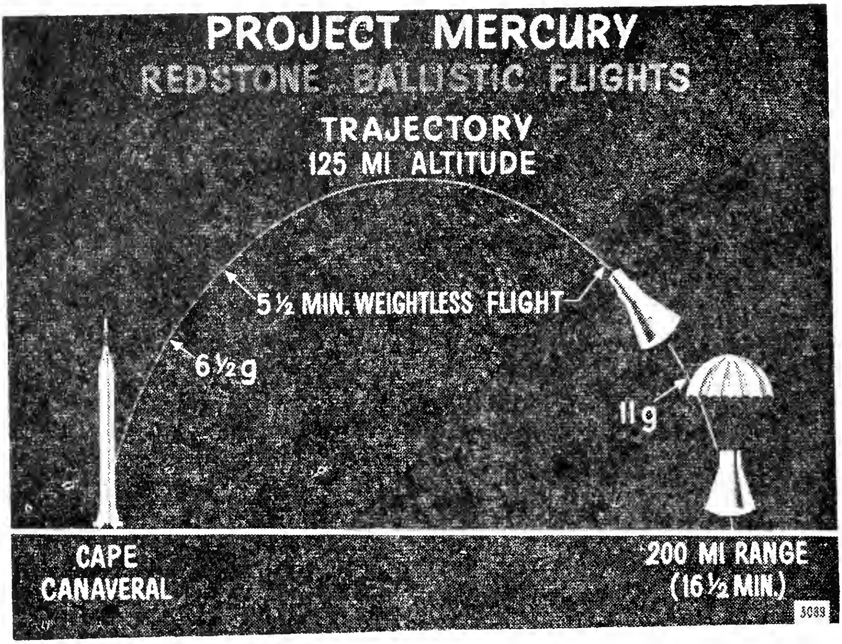

FIGURE 156

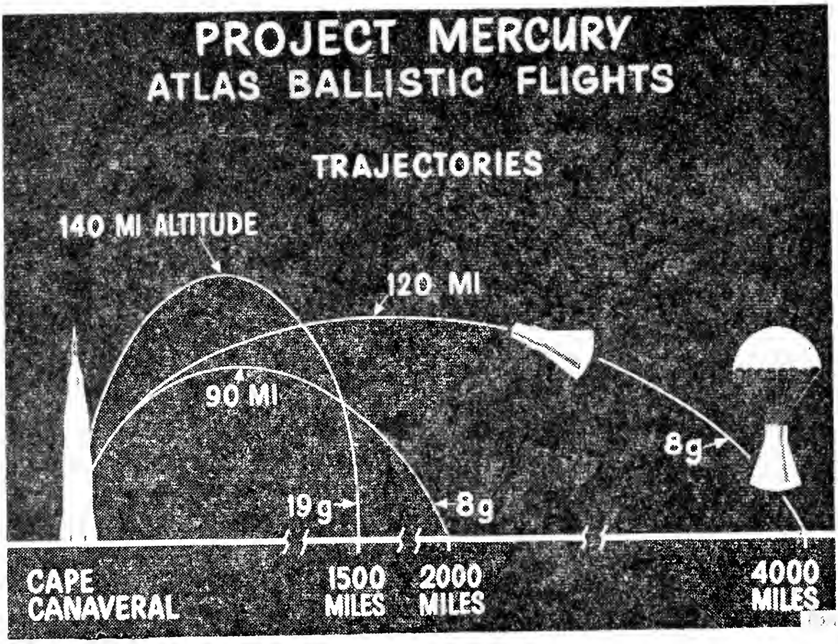

FIGURE 157

All of the Atlas ballistic flights will be unmanned. Without going into a great deal of detail, let me just say that by having three different types of Atlas ballistic flights we will cover all of the forces and heating, and the entire speed range that will finally be encountered in the orbital mission.

In the orbital mission (fig. 158), the Atlas will carry the capsule to an altitude of about 120 miles; the speed in orbit, I mentioned before, will be 17,500 miles an hour. Each orbit will last about 90 minutes. It is planned to keep the capsule aloft for 4½ hours, or three orbits.

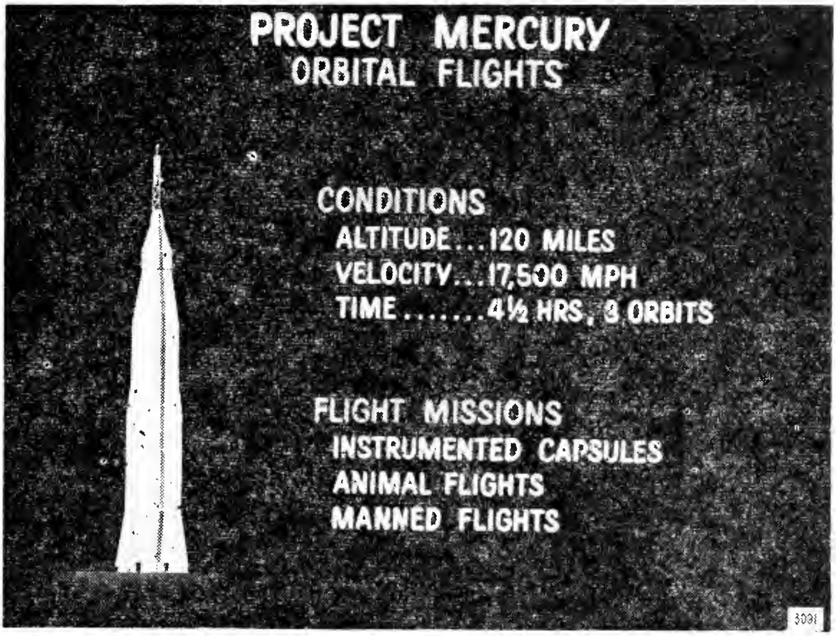

FIGURE 158

Again, in the orbital missions we will initially have instrumented capsules, later on capsules containing an animal, and finally the manned orbital flight.

The next chart illustrates some of the operational plans for the orbital mission (fig. 158, p. 750).

The launch will be from Cape Canaveral in a direction toward Bermuda. The shaded areas on this map illustrate the planned recovery areas. Ships and airplanes will be deployed in all of these areas in order to pick up the capsule as quickly as possible after it comes down.

The five areas between Cape Canaveral and the African coast are provided for emergency landings. If it is found either on the ground or within the capsule that for some reason it will not be possible to complete at least one orbit, then immediate action will be taken to bring the capsule back down. It would then come down in one of these five areas in the Atlantic Ocean.

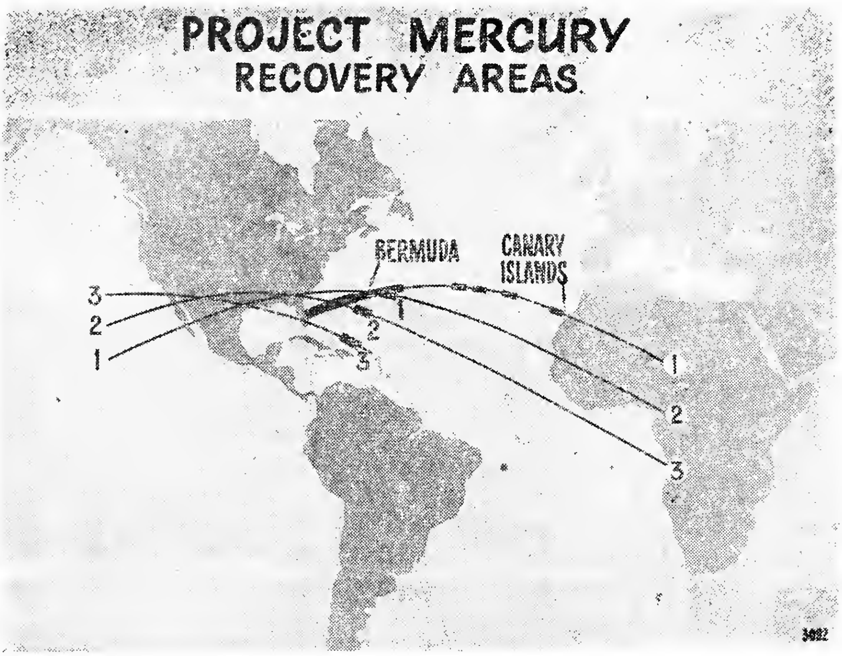

FIGURE 159

Emergency landing areas are also provided at the completion of the first and the second orbit.

While the capsule is in orbit it will be tracked by some 18 stations, and communications with those stations will be possible. I believe that the Mercury tracking network was discussed yesterday by Major Hammond.

At the end of the third orbit the retrorockets will be fired just west of the California coast. The capsule will then descend toward the atmosphere, enter the atmosphere, and land in this area of the Atlantic Ocean. It will then be picked up by waiting ships.

Mr. RIEHLMAN. If the parachute operates properly, at what speed would the capsule be hitting the water?

Mr. LOW. At 30 feet per second or about 20 miles an hour. This speed is the equivalent, I believe, to the speed reached by a man after jumping off a 14-foot wall.

Mr. RIEHLMAN. Then, if the capsule should land on the Earth, it certainly wouldn't be destroyed because of the speed it will be traveling?

Mr. LOW. No, sir.

The CHAIRMAN. At 20 miles an hour, don't you get some air friction?

Mr. LOW. It will land at about 20 miles an hour.

The CHAIRMAN. I mean the orbit?

Mr. LOW. The orbit? In a 120-mile orbit the capsule would not stay aloft indefinitely. There is enough air up there to bring it down in perhaps 4 or 5 days.

The CHAIRMAN. But won't it build up a lot of heat from friction?

Mr. LOW. Not while in orbit. It will only be heated after it reenters the atmosphere at a much lower altitude.

The CHAIRMAN. You assume there is no air at 120 miles?

Mr. LOW. There is so little air up there, and the air is not very dense, so that it cannot heat the capsule very much.

Mr. MOELLER. On the third orbit, as it is coming down, it should be visible over a good share of the United States, should it not?

Mr. LOW. Yes, sir.

My next chart (fig. 160) shows our projected Mercury schedule. First, I have listed the schedule for the Little Joe vehicle, which is a launching vehicle used in the research and development program, the first one of the display models. The first Little Joe flight took place in October 1959. Additional flights were made in November and December 1959, and one in January 1960.

We plan to make at least one more Little Joe flight in the first half of this calendar year.

Redstone flights will start in about the middle of this year, and carry on for approximately 1 year.

The first Atlas ballistic flight took place in September 1959. This flight, again, will be shown in the motion picture. We plan to resume Atlas ballistic flights in about the middle of this year, and after a series of ballistic flights we will then have the instrumented orbital flights, followed by animal orbital flights, and manned orbital flights.

I would now like to show the motion picture which is in three parts.

First, it will show some of the accomplishments in the Mercury research and development program, of the past year. Secondly, there

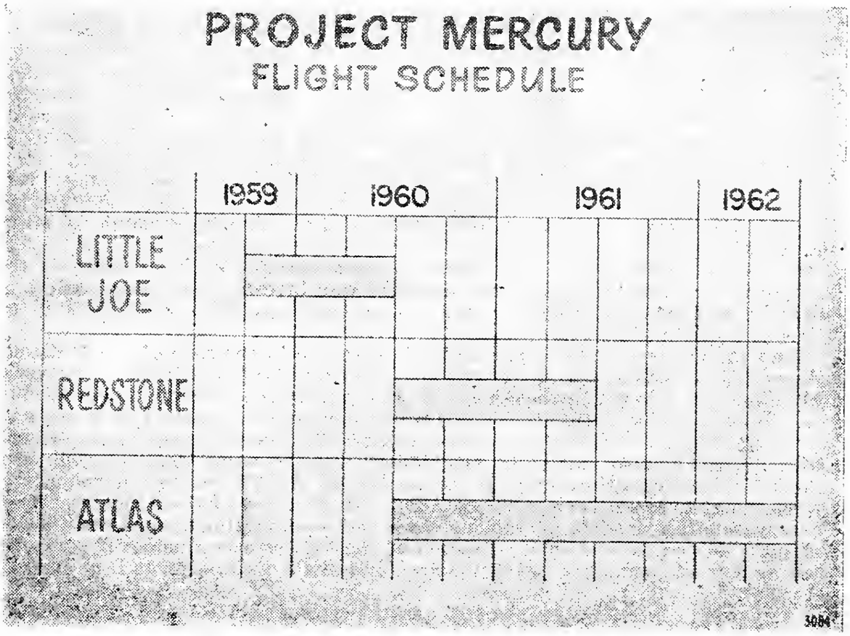

FIGURE 160

will be a few short scenes showing the Mercury astronauts and their training program, and the third part deals with the production of Mercury capsules.

May I now have the motion picture, please.

(A sound motion picture was shown, the sound track of which is as follows:)

Film Report—Project Mercury, December 31, 1959

Project Mercury is the name given to the Nation's manned orbital space flight program being conducted by the National Aeronautics and Space Administration. It involves a continuing broad research program.

WIND TUNNEL TESTING

The Mercury capsule shape was determined from intense scientific and engineering investigations using a wide variety of technical equipment. The moment of inertia on test models was determined on this pendulum rig. Wind tunnel tests of small- and large-scale models have been carried out covering a speed range from zero to 18,000 miles per hour. Small models of the capsule were fired in this supersonic free-flight ballistic gun range. In the gun, helium compressed by a powder charge accelerates the 1-inch model down a 30-foot instrumented range of recording stations. The model achieves speeds of up to 10,000 miles per hour. Data are recorded by means of special cameras located along the length of the range. As the model speeds down the gun range barrel, photographs and shadowgraphs are acquired. This shadowgraph taken at one of the recording stations clearly shows the flow of air passing around the model at supersonic speeds. Detailed analysis of data acquired in tests of this nature provides a solid basis for proceeding to more complex tasks, and to improved version of the capsule shape.

In other tests, a small model was instrumented to measure the scorching heat of reentry as simulated in a shock tunnel. The air in this tunnel rushes past the model at 14 times the speed of sound. The severe heating ionizes the air in the region of the heat shield, causing it to glow. In another wind tunnel facility, free-falling models were used to determine the best attachment points for the parachutes. And a detailed picture of the flow of air over the capsule at relatively low speeds as obtained by observing the movement of pieces of yarn glued to the surface of the model. Full-scale capsule models were tested in a large wind tunnel to determine the capsule's lift, drag, and pitching moment characteristics.

The validity of the Mercury configuration had to be established not only for the capsule alone but also for the capsule with the escape tower. In a typical wind tunnel experiment, a scale model of the escape configuration was tested over the speed range from 1½ to 4½ times the speed of sound. During the test, the model was forced to oscillate to determine its dynamic stability characteristics.

In other tests the effect of the Mercury capsule of the performance of the various boosters to be used in the program was investigated. The static stability of the capsule fitted to an Atlas booster was determined in a 9- by 7-foot supersonic wind tunnel.

Wind tunnel tests were of particular importance in the case of the Redstone booster. The Redstone is an aerodynamically stabilized vehicle as is evidenced by the large tail fins. In these tests, it was determined that the booster would coast along a stable path, even if the rocket engine was suddenly shut down.

The stability of the Little Joe booster with the mercury capsule and escape system installed also had to be established. In the wind tunnel testing program, Mercury experiments were performed in 26 different wind tunnels of the National Aeronautics and Space Administration and of the Armed Services. Seventy separate models of various sizes and configurations were constructed and 106 tests were conducted. In each of the 106 tests, a number of variables such as Reynolds number, mach number, and angle-of-attack was investigated.

FULL-SCALE CAPSULE MODELS

But wind tunnel tests alone are insufficient to solve all of the many problems associated with the Mercury flight system. A flight test program using full-

scale models of the Mercury capsule was, therefore, initiated. These boilerplate models, which are made in NASA's shops, duplicate fully both the weight and the external shape of the final Mercury operational capsules. Their construction is greatly simplified through the use of heavy welded sheet metal. They do not include many of the Mercury subsystems, such as the life-support system, or the communications equipment. These boilerplate capsules have been used to develop the parachute system, to validate recovery procedures, project the functioning of the escape system, and to determine the motions and heating of the capsule during reentry.

AIRPLANE DROP TESTS

Large cargo airplanes were used in the development of the parachute system. Full-scale boilerplate capsules were dropped from Air Force C–130 aircraft at high altitudes. The capsule slides out of the plane's cargo door on a sled. As soon as it is clear of the aircraft, the sled is released, and after a period of free fall the lid on the antenna canister is released. Then the small drogue parachute is ejected by a mortar charge. This parachute reduces the capsule's swinging motions in the early stages of the descent. At a predetermined altitude a small parachute pulls the top antenna housing away from the capsule and automatically deploys the main descent parachute. The capsule then descends toward the water. The main descent parachute is a 63-foot ring-sail type cargo parachute. Upon impact on the water, the parachute is released from the capsule by a small explosive charge to avoid dragging the capsule in the wind.

The airplane drop tests also provide an opportunity to exercise the various recovery devices and to further develop and improve recovery operational procedures. After impact, a smoke generator is energized to emit smoke from the top of the capsule to aid the visual search. This is a view of the capsule from an approaching recovery vessel. A green dyemarker solution is released from the base of the capsule to help make it visible from greater distances and altitudes, and the small antenna on top of the capsule transmits signals from the automatic rescue beacons to searching ships and aircraft.

ESCAPE SYSTEM TESTS

Concurrent with the airplane drop tests, an extensive rocket flight test program has been initiated. At the National Aeronautics and Space Administration's launch site at Wallops Island, Virginia, tests were performed to develop the emergency escape system and qualify it for future use on manned flights.

Escape from the launching pad can be simulated by lifting a capsule from the ground with the escape rocket as the only means of propulsion. After ignition the escape rocket burns for only 1 second. It appears to burn much longer here in this slow-motion sequence. In an inflight orbit, the capsule would be carried at least 250 feet away from its booster, during the first second. The capsule and the tower then coast together to the peak of the trajectory. The gentle rotation is caused by a deliberate offset of the rocket thrust to provide a lateral displacement of the capsule as it leaves the booster. This rotation would impose only small loads on the pilot inside the capsule. At a maximum altitude, the tower is separated from the capsule with a small rocket. Then the antenna housing lid is released, and the small drogue parachute is ejected by a mortar charge. After the swinging motions of the capsule have been reduced the drogue parachute and the antenna housing are jettisoned, automatically deploying the main parachute. On impact, the parachute is automatically disengaged from the capsule.

In an off-the-pad abort, the capsule reaches an altitude of more than 2,000 feet. The main parachute was deployed and opened fully about 1,000 feet, providing ample time for the use of the reserve safety parachute if required. In these tests the capsules were recovered by helicopters and returned to Wallops Island for further use in the test program. The tests also provided an opportunity to conduct development work on the recovery and pickup techniques.

LITTLE JOE BOOSTER

Other flight tests are being carried out with a series of booster vehicles of increasing size and capability. The smallest of these is the Little Joe booster. The Little Joe airframe, produced especially for Project Mercury by the North

American Aviation Corp., houses four large Castor solid-fuel rockets and four smaller Recruit rockets. The holes in the base of the vehicle indicate the relative sizes of these rockets. The Little Joe booster is unguided and derives its aerodynamic stability from four large tail fins. One of these fins is shown here as it is being assembled on a special fixture.

Preliminary testing of the completed airframe is accomplished in a static test tower at the North American plant. The use of the Little Joe boosters in the Mercury development program provides an economical means for simulating many of the most severe launch emergency escape and recovery conditions.

Final assembly of the booster takes place at Wallops Island. First the rockets are erected, then the airframe is fitted around them. The capsules used in the early phases of the Little Joe program were manufactured in NASA's shops and do not contain many of the systems and subsystems that will be part of the Mercury operational capsules. The escape tower and rocket, however, are final production hardware, being qualified in the Little Joe program.

In the fall of 1959, three Little Joe vehicles were launched successfully. The first was a test of the basic booster system. In the second test, the escape mechanism was activated intentionally during the early phases of flight. This test simulated a severe escape condition that could occur in an orbital flight launch. The capsule was recovered undamaged shortly after landing. The third flight was used to perform an escape maneuver at high altitude. After a planned escape, the capsule coasted to an altitude of 55 miles and was recovered 200 miles from the launch site. On this flight, a small monkey was within the capsule and was recovered alive and well at the end of the flight.

Before the firing the scaffolding is removed and the booster is supported on a simple launcher. On takeoff, two of the Castors and four Recruits are ignited, giving a thrust of one fourth million pounds. The smaller Recruits burn for only 1 second, while the Castors have a burning time of 27 seconds. The second pair of Castors will be ignited just before burnout of the first pair, but at an altitude too high to be visible from the ground. The remarkable stability of the Little Joe booster is well demonstrated in this flight. Later on in the flight, the escape rocket is ignited, separating the capsule from the booster.

At the completion of the escape sequence, the capsule falls back toward the ocean and parachutes are deployed. Recovery is accomplished by Navy ships. After recovery the capsule is hoisted on board with a special net-like device and returned to NASA facilities for visual inspection and for an analysis of the data recorded during the flight.

BIG JOE FLIGHT

The Atlas booster was used in the most severe test of the Mercury system that has been performed to date. In that test, a research and development version of the capsule was launched from Cape Canaveral, Fla. In contrast to the Little Joe vehicle, the combination of the developmental Mercury capsule with the Atlas booster was nicknamed Big Joe.

The trajectory for this flight was shaped to simulate a return from orbit without actually going into a satellite orbit. The objectives of the Big Joe test were to check the capsule's heat protection at nearly orbital speed; to verify its aerodynamic stability; to provide a severe test of the onboard recovery system; and to develop recovery procedures in a realistic test situation.

The Big Joe capsule was taken to the launching pad several days prior to the shot. Within the capsule is special instrumentation to measure the loads, noise, motions, and temperatures during flight, and a control system to orient it into the proper attitude after its separation from the booster.

As the capsule is hoisted to the top of the gantry, the plastic heat shield, designed to dissipate the tremendous heat of reentry, is clearly visible. The capsule is mated to the top of the Atlas booster and attached with a special clamp. The clamp will be released explosively after the Atlas engines are shut down. The special Mercury capsule used in this test was not fitted with an emergency escape system.

The booster and capsule systems and their instrumentation were checked and rechecked during the days prior to launch. A joint Defense Department Recovery Task Force was deployed along the capsule's intended flight path. The launch was made in the early morning hours so that a full day would be available for the recovery operations if required.

In the blockhouse, the countdown proceeds for many hours before the firing. Here the functioning and readiness of thousands of component parts of both

the booster and the capsule are recorded. The malfunction of any one of these parts could make the difference between a successful flight and a complete failure.

Minutes before the firing, liquid oxygen is piped into the booster which is now ready for flight. As the countdown approaches zero, the final switch is closed and Big Joe is launched. This Atlas booster carried the capsule to an altitude of 100 miles and to nearly orbital speed. The Big Joe capsule was then separated under conditions that closely simulated orbital reentry. On the recovery ships the capsule appeared as a flaming fireball as it streaked back into the atmosphere. Many hundreds of miles from Cape Canaveral, airplanes vectored to the impact area and soon picked up the capsule's recovery signals. Two destroyers raced to the area and sighted the capsule about 8 hours after launch. The capsule was picked up by the destroyer *Strong* and returned for a detailed inspection and for an analysis of recorded data. It had survived its reentry in excellent condition.

The recovered Big Joe capsule represents a major milestone in Project Mercury in that it positively demonstrated the validity of the Mercury design concept.

MERCURY ASTRONAUTS

Early in 1959, a team of seven engineer test pilots was selected for Project Mercury: M. Scott Carpenter, L. Gordon Cooper, John H. Glenn, Virgil I. Grisson, Walter M. Schirra, Alan B. Shepard, and Donald K. Slayton.

Following their selection, the men reported for duty with NASA's Space Task Group at Langley Field, Va. Their training, which has been in progress since April 27, 1959, includes both academic classroom instruction and practical experience in training devices across the country. The academic program includes instruction in the basic sciences related to space flight, astronautics with detailed studies of propulsion systems, electronic systems, guidance, trajectories, and other technical aspects of rocket training.

In addition to a penetrating study of physiology of flight, the astronauts are being educated in the basic skills required to make scientific observations during orbital flight.

SUPPORTING COUCH

As the training program progresses, the development and production of special flight equipment has continued. Each astronaut has been fitted with a custom-made couch developed to support his entire body and reduce the physiological effect of high acceleration forces or g's. To make the couch, the astronaut is placed in a bed of quick-hardening sand. After the sand is carefully packed around the astronaut's body, carbon dioxide is applied to speed up the hardening process. At the end of the 2-hour long couch molding process, the astronaut is carefully lifted out of the mold. These Mercury couches were produced at NASA facilities with painstaking care to assure proper fit and effectiveness in protecting the pilot during flight.

HEAT INDOCTRINATION

During reentry into the Earth's atmosphere, the Mercury capsule will be subjected to intense frictional heat. One of the early practical training activities for the astronauts provided familiarization with high heat conditions and the ability of the ventilated full-pressure suit to keep them cool under these conditions. This heat chamber is capable of producting the same temperatures anticipated inside the capsule during the reentry from orbit. Quartz tubes along the outer walls provide the chamber with heat. In this test, the pressure suit ventilation system was turned off to familiarize the astronaut with his own physiological reaction to short periods of high heat.

FLIGHT SIMULATORS

In Project Mercury, the pilot will play an active role in the operation of the Mercury satellite. He will be able to control the capsule's attitude. He can maintain current knowledge of his position visually and through the use of radio-navigational aids. He will be able to operate all primary flight controls, such as the firing of the retrorockets to begin his descent toward the atmosphere and to deploy the parachutes once he has reentered the atmosphere. Wherever possible, the capsule's flight performance is simulated on the ground to provide realistic economical training for the astronaut.

In this fixed-seat analog simulator, instrument readings indicating a simulated capsule attitude are supplied by an analog computer. The pilot responds to the instrument readings by applying the proper control movements with the sidearm controller. In flight, this controller would activate small reaction jets to turn the capsule about its three primary axes. On the simulator, the control movements feed signals to a computer and result in changed instrument readings portraying the capsule attitude changes which would have resulted from control movements in flight. Training on such simulators, the astronaut develops skill in maintaining the capsule's orientation during orbit, retrofire, and reentry.

Following the indoctrination on the fixed-seat static simulator, the pilots will be trained on a cynamic simulator. On this device, the astronaut will be supported in a molded coach. His sidearm controller will be connected to a system of reaction jets similar to the ones in the Mercury capsule. These jets will rotate the coach, or pitch it up, down, or sideways. An intricate system of motion picture displays will give a view similar to that seen by the pilot in orbital flight. A special feature of this simulator is a low-friction air bearing, designed to permit movement in all directions around a center post.

CENTRIFUGE TRAINING

One of the most important phases of the preflight training is that received on the centrifuges at the Wright Air Development Center and at the Aviation Medical Acceleration Laboratory at Johnsville, Pa. These centrifuges have the capability for reproducing the same acceleration or g-forces on the same time scale as will be encountered during the rocket-boosted launch and the reentry into the Earth's atmosphere. In this training, the astronaut learns more about the effect of these g-forces on his ability to perform his inflight functions and what he can do to overcome those forces.

While whirling around in the centrifuge cab, they learn new techniques of breathing and straining, so that they can tolerate these high g-forces while still performing functional control tasks. The centrifuge is operated in response to signals provided by a computer. The sidearm controller also gives electrical signals to the computer. These signals are translated into motions the reaction jets would have given to the Mercury capsule in flight. These signals result in changes in g-forces within the centrifuge cab comparable to those encountered in actual flight. The test demonstrated that a properly trained man in good physical condition would be able to control the Mercury capsule even while being subjected to the high g-forces of launch or reentry.

In other procedural trainers, the astronaut will be checked out completely and repeatedly in all of the procedures in operation of the capsule.

CAPSULE CONTRACTOR

In January 1959, the McDonnell Corp. was selected as the prime contractor to design and construct the Mercury capsules. The selection was based on industrywide competition. In the course of this competition, 12 firms submitted proposals based on NASA specifications for the capsule. After a thorough evaluation of these proposals, a contract was awarded to McDonnell.

An engineering mockup of the capsule was completed by McDonnell in March of 1959. The mockup was complete in every detail, including the escape tower and rocket, the antenna housing, the parachute container, the capsule proper, and the adapter ring that connects the capsule to its booster. The mockup also included cockpit equipment and control layouts. Engineers and officials from NASA met with contractor personnel to assure that specifications governing the capsule's design and the installation of equipment and components were complied with. Special attention was paid to the pilot-support system and to the type and location of pilot displays.

After the mockup inspection had been completed, an official mockup board consisting of NASA officials and military and aeromedical advisers made final recommendations.

The Mercury astronaut trainees visited McDonnell shortly after they reported for duty. All engineers, these men are making a positive contribution to the design of the capsule and determine that all of the capsule systems are compatible with manned operation. Working with the mockup, the astronauts review the pilot displays and check on the accessibility of controls, supplies, and emergency equipment. The location of windows and the ease of entry and exit through the main and emergency hatches was also studied by these men.

CAPSULE CONSTRUCTION

Construction of the capsule was started immediately. Special welding techniques were developed. An argon atmosphere fusion welding machine is used in the fabrication of the thin titanium pressure vessel. The shell is carried past a circular electrode by rotation of a fixture. The pressure vessel consists of a smooth inner skin and a beaded outer skin. Each of these is only ten-thousandths of an inch thick. After the two skins are welded together, stringers, window and door frames, and bulkhead rings are installed. An additional skin will be attached to the stringers.

COMPONENTS AND SUBSYSTEMS

Many of the component parts of the capsule are made by subcontractors under McDonnell supervision. The all-important heat shield is manufactured by the Cincinnati Testing Laboratories. This ablation-type shield is made to the same specifications as the one that survived the Big Joe reentry. During reentry its surface will char and slowly burn away. Through this ablative action the heat of reentry will be dissipated.

Other major subcontractor items are the life-support system, the attitude control system, the horizon scanner, the escape and retrorocket systems, parachute landing system, batteries, and the navigation periscope.

The periscope, which is shown in this sequence, is manufactured by the Perkin-Elmer Corp. With the aid of this periscope, the pilot will be able to perform the functions of attitude stabilization and control and fire his retrorockets even if all of his automatic systems should fail. He will be able to determine his attitude, his orbital track, and the ellipticity of the orbit. Once he has made a precise determination of all of the orbital elements he will be in a position to fire the retrorockets at the proper instant so that he will land in a prescribed recovery area.

GROUND SUPPORT EQUIPMENT

An operation as complex as that of putting man into space requires a great deal of ground support equipment. The equipment for this ground support is being developed by McDonnell and its subcontractors.

A typical example of this type of ground support equipment is the array of electronic instruments to be used in the checkout of the capsule's communications gear. Once the capsule is in orbit, the pilot will rely completely on his various channels of communication, such as the radio voice transmitters and receivers, and the various tracking and rescue beacons. His actions will be monitored by other communications channels and certain capsule functions will be commanded from the ground.

The proper functioning of all of this equipment can be guaranteed only by checking it in every detail during the days, the hours, and the minutes before launch. Similar equipment is being fabricated to check all of the other capsule systems on the ground and to monitor their functions during flight.

The ground support equipment will be installed in a number of trailers so it can be transported to the launching site and utilized in several different locations.

Because both Redstone- and Atlas-launched Mercury flights will take place concurrently, some of the equipment must be duplicated. Two of the trailers shown here will house checkout equipment, while telemetry receiving equipment will be installed in two more. A fifth trailer will contain spare parts.

CAPSULE ASSEMBLY

In the fall of 1959, many of the capsule components reached the final assembly stage. The housing for the three retrorockets is equipped with a shield and with insulation to maintain the rockets at the proper temperature and to protect them from meteorite damage. A number of the top antenna canisters have been manufactured and are ready for the installation of their electronic components. Several of the escape system towers have been assembled and prepared for shipment. Some of these have been flight tested in the off-the-pad abort and Little Joe experiments conducted at Wallops Island.

Final fabrication of a number of capsules is well underway. On the production line at the McDonnell plant, several capsules are in various stages of construction. On this line, the pressure vessel is fitted with the upper and lower pressure bulkheads. A large number of brackets and fixtures is installed for the support of the capsule's subsystems, the wiring, the reaction control fuel

lines. At the top of the capsule, the emergency exist hatch is visible. Windows and entry hatch are located along the sides of the shell.

After the capsule fabrication is completed, the various subsystems will be installed. The assembled capsule will then be subjected to an intensive environmental testing program. The entire system must be able to withstand extreme heat and cold, high pressure and vacuum, vibration and noise, and high accelerations. All of these tests will be performed on the ground before the capsule will be certified as being ready for flight.

Project Mercury, the Nation's manned orbital space flight program, is a continuing program of concurrent efforts in research, development, engineering, manufacturing, test, and training, all aimed at the focal point of successful manned space flight at the earliest possible time.

The CHAIRMAN. That is very fine.

Mr. LOW. I have just one more chart (fig. 161). We have attempted to illustrate with the motion picture some of the difficult tasks that confront us in a project of this magnitude. The funds required to carry out this program are listed on this last chart. The major expenditures are for the procurement of boosters and the capsules, themselves; for fiscal year 1961 we are requesting $107,-750,000 to carry on this project.

Thank you.

The CHAIRMAN. Thank you very much.

Now, is there anything more for this afternoon?

Mr. SISK. Could I ask just a question before he goes?

The CHAIRMAN. Surely.

Mr. SISK. How much has actually been expended on the project for 1960? Does that indicate it?

Mr. LOW. For 1960 our allocation was almost $75 million.

Mr. SISK. Is that all programed now? Will it all be spent by the 1st of July?

MANNED SPACE FLIGHT

COSTS (IN MILLIONS)

	FY 1960	FY 1960 SUPPLEMENTARY	FY 1961
ADVANCED TECHNICAL DEVELOPMENTS			
BIOLOGICAL AND HUMAN ENGINEERING STUDIES	2.18		2.09
MERCURY DEVELOPMENT PROGRAM	5.27		4.05
ADVANCED RE-ENTRY CONFIGURATIONS	.10		1.00
FLIGHT RESEARCH PROGRAM			
MAJOR BOOSTERS	23.46		25.65
MERCURY CAPSULES AND SUPPORT EQUIPMENT	35.01	12.00	35.29
TRACKING NETWORK AND RECOVERY OPERATIONS	8.94		39.67
	$ 74.96	$ 12.00	$ 107.75

5009

FIGURE 161

Mr. Low. Yes, sir, it will all be obligated before July. In fact, we are requesting a supplemental of $12 million in 1960.

Mr. Sisk. That was really the reason for my question. I did not understand that you were asking for a supplemental on this. I understand there is a $23 million supplemental for the Saturn.

Mr. Low. No, sir, this $12 million is part of the $23 million supplemental.

Mr. Sisk. I see.

Mr. Low. And the funds included in the supplemental were authorized last year but not appropriated.

Mr. Sisk. But not appropriated. So actually you expect to need and to actually spend in fiscal 1960 about $86 million or $87 million?

Mr. Low. $87 million; that is right.

Mr. Sisk. And you propose $107 million. I was just trying to get a comparison.

Mr. Low. Yes, sir.

Mr. Bass. Mr. Chairman.

The Chairman. Yes, sir.

Mr. Bass. While the pilot is in flight, I gather he will not use the manual controls unless the automatic controls fail?

Mr. Low. He does not have to use them unless the automatic controls fail. But since the major objective of the project is to determine the pilot's capabilities in flight, certainly we expect him to try to use the manual controls to show us how capable he is of performing various tasks in space flight.

Mr. Bass. When he actually goes into orbit, is he going to exercise his own judgment as to whether he will use the manual controls?

Mr. Low. Yes, sir.

The Chairman. Any further questions?

Mr. McDonough. When do you anticipate the first manned flight?

Mr. Low. The first manned orbital flight?

Mr. McDonough. Yes.

Mr. Low. Hopefully, within 2 years, but I should mention that all we can predict today are target dates. We don't know—we have not yet flown a production capsule. We are moving a tremendous step forward with this program; we are increasing the speed, for example, of manned flight to a factor of almost 10, the altitude by a factor of almost 5. We don't know what difficulties we are going to encounter as we carry the program down the road, so that any dates we predict now must be considered only as target dates. They may be changed as we go further on.

Mr. McDonough. If you do arrive at a manned flight in 2 years, you will pick one of the seven astronauts that are being trained?

(Mr. Low nods.)

Mr. McDonough. And if the first flight is successful, then out of the other six remaining will be the next man. Is that the program?

Mr. Low. Presumably so.

Mr. McDonough. Thank you.

Mr. Sisk. Is the gentleman finished?

Mr. McDonough. Yes.

Mr. Sisk. Mr. Chairman, could I just ask him this? Maybe it is not a good question, but is the only reason why we are proposing to

send only one man to start with a matter of weight, strictly a matter of thrust? My colleague, Mr. Fulton, touched on some of the magazine articles we read. I am sure we all read the various rocket magazines. The idea was proposed in an article recently that perhaps it would be better for two people to make the flight, taking into consideration the psychological problem that would be involved in making a flight of a longer duration than four and a half hours. I am just curious if that was the only consideration, this matter of weight, that one man goes instead of two.

Mr. Low. It certainly is the most important consideration. As long as we are tied to the Atlas booster, and until the Saturn or bigger launching vehicles come along, we are limited in weight, and we have all we can do to get a one-man capsule into orbit.

Mr. Sisk. That has been my understanding all the way through. The theory of this particular individual in his article was that companionship was needed to overcome the great loneliness that comes in a flight of this type.

The Chairman. Any further questions? Mr. Hechler?

Mr. Hechler. Mr. Low, have you seen the committee's staff report on Project Mercury?

Mr. Low. Yes, sir, I have.

Mr. Hechler. There is a statement in the report that—

> in official announcements NASA has wisely refused to commit itself to any time schedule which might bring a temptation to launch a man before the level of development fully justified the step.

I was a little afraid in your answering my colleague maybe you were starting to pin this down. I think this is a wise doctrine stated in our committee report.

Mr. Low. I tried to make the point that we cannot really pin it down because we don't know yet.

Mr. Hechler. This Mercury project has a tremendous psychological value from an international standpoint, would you agree?

Mr. Low. Yes, sir.

Mr. Hechler. And I am just wondering, would you say that this is the primary value of it?

Mr. Low. No, I don't think so. We are certainly moving along in this project as quickly as we possibly can. We have as one of our objectives to do this mission at an early date. But beyond that we must accomplish manned space flight because our entire space flight effort is hinged on the belief that man will be part of it, not only in Mercury, but in many future missions. And we must, therefore, determine at a very early date exactly what man will be able to do, what he will be capable of doing, so that we can then go on to the next steps.

Mr. Hechler. The reason I asked this was I wanted to ask specifically what scientific value will accrue from this as opposed to later space flights, perhaps, of greater distances with larger boosters that might be designed to produce greater scientific results. I had a feeling that perhaps there was an element of psychological prestige involved here which was far outweighting the scientific value. I just wanted to get your comment.

Mr. Low. There is certainly some of both involved. But I do very strongly believe that there is a definite need to learn about man's capa-

bilities in the space environment, and Mercury was designed to give us those answers.

Mr. HECHLER. One of the reasons I am asking these questions is to try to see if we can learn from the lesson of Vanguard and not give Mercury the kind of tremendous advance buildup that might result in a letdown if things should develop that we happen to be second in space. Russia, after all, has demonstrated in putting a dog into flight and by other means, through the use of her large boosters, that she may have the capability of putting a man up there before we do. If we stake so much prestige on this, isn't this running us into a little international danger?

Mr. LOW. Well, this is precisely why I am trying to make the point that, yes, we would like to be first, but even if we are not, this is still an important first step in our manned exploration of space.

Mr. HECHLER. One final question, which relates to the funding. Because of the extreme importance of this, I am sure other members of the committee also are deeply concerned that the program is adequately funded. Are you personally satisfied that the program is adequately funded?

Mr. LOW. Yes, sir, I am, provided we can get our supplemental approved; the funds we have requested are adequate funding for the Mercury program.

The CHAIRMAN. We have a job to do to help NASA get its supplemental.

Mr. HECHLER. Mr. Horner indicated he might want to add to that.

Mr. HORNER. To the funding question?

Mr. HECHLER. Well, any other comments?

Mr. HORNER. I had shaken my head at your suggestion that the primary purpose of the project Mercury was one of national prestige and psychological advantage. We are not approaching the project in that manner. The primary purpose is to determine the feasibility and the utility of manned space flight, and this in fact is a prerequisite for most of our follow-on space program.

You will recall from our 10-year plan that one of the major objectives in the latter part of the decade, for example, was manned circumlunar navigation. Now, clearly we cannot take on that kind of an objective until we determine for ourselves whether manned space flight is practical. We have approached project Mercury using the simplest, most reliable and, therefore, you might say the earliest method of determining whether or not manned space flight is practical in terms of its feasibility, in terms of the utility of a man in space.

You asked, also, the question: What was the scientific product of this?

Well, contrary to many of our other experiments, perhaps most of the scientific product of this project is going to be in the life sciences area, rather than in the physical sciences area, and it is different in that respect; but it is extremely important that we have these life sciences returns if we are going to carry on with the manned space program.

Mr. HECHLER. Thank you, Mr. Horner.

The CHAIRMAN. We certainly thank you, sir. If there is no further business we will adjourn until tomorrow morning at 10 o'clock.

(Whereupon, at 4:32 p.m., the committee adjourned, to reconvene at 10 a.m., Wednesday, February 17, 1960.)

REVIEW OF THE SPACE PROGRAM

WEDNESDAY, FEBRUARY 17, 1960

HOUSE OF REPRESENTATIVES,
COMMITTEE ON SCIENCE AND ASTRONAUTICS,
Washington, D.C.

The committee met at 10 a.m., Hon. Overton Brooks (chairman) presiding.

The CHAIRMAN. The committee will come the order. Now, this morning I want to read a letter to the members of the committee from Mr. McCormack that will explain the situation very well. It is addressed to me, as chairman.

> The leadership on both sides feels that it is highly advisable, if possible, for the Congress to complete its business before the national conventions of both parties meet. If we do not, it means that Congress will adjourn the early part of July and come back in August, and if this happens it is anyone's guess as to when the Congress will finally adjourn. It is my frank opinion that it would be a hard task to accomplish adjournment before July 11, but it can be done. In order to do this it will require intense work by all the committees and subcommittees and the members thereof because there are some ways that this can be accomplished:
>
> 1. Committees giving first consideration to bills that should be or must be acted upon at this session.

And that is the authorization bill to which we must give consideration.

> 2. Whenever possible, afternoon meetings and even some evening meetings, particularly in the case of committees under pressure. For example, where a large number of bills require hearings have been referred to them or in case of bill with protracted hearings, or in case a very important bill requires hearings in subcommittees.
>
> 3. Committees or subcommittees confronted with the above situation meeting early in the morning, say at 9 to 9:30.

Now, there is a nice thought for you subcommittee chairmen—that evening meeting. [Laughter.]

> I am respectfully submitting to you, it is in the hope of both parties that we can finish our business and adjourn, sine die, before the national committees meet.

The rest of the letter does not pertain to the present work of the committee.

Signed, John McCormack.

John is not here, but he wants the committee to know about it. He will be here later. I think that speaks for itself. Now, we have these hearings this morning, we have hearings this afternoon especially to collate the work of the subcommittees on the NASA bill, and I am very anxious for the chairmen of the subcommittees to be present. And tomorrow morning—and that will just about finish up these posture hearings. After that we thought a week—I think the full com-

mittee can handle the bill in a week and I think the subcommittees can do it easily in a week. So if we can get that bill back to the full committee by Thursday week, that is tomorrow week, we can go over it in the full committee and get it in shape to be introduced and disposed of, that is as far as bringing it to the House is concerned, by Monday of the following week. Then it would be up to us to get it through the House. I want to commend the Republicans for having excellent attendance here recently, and I want to commend the Democrats, well down on the committee list, for their fine attendance. A little higher up——

Mr. FULTON. Let's not have it low and high. Let's have it new and newer.

The CHAIRMAN. I want to commend the newer members of the committee for their fine attendance. Now, if we will bear up these next 2 days, let's see how your attendance shows——

Mr. TEAGUE. If you can figure out a way to be in three places at the same time, I will be in every meeting every second.

The CHAIRMAN. Olin has a hard job there. I called him this morning—one thing about Mr. Teague, when you call on him to do a job, he will do it.

Mr. TEAGUE. Our committee's work is fascinating and interesting to me, but I have a meeting every day this week on the Veterans' Committee on a $900 million hospital building program.

The CHAIRMAN. Now, as chairman of the full committee I am not going to interfere with the subcommittees. I want them to do their own job. If a subcommittee chairman gets in trouble I will be glad to pinch hit and help him. Furthermore, I probably will arrange to sit with one subcommittee and then another subcommittee, just looking in, with the subcommittees doing the job. I am ex officio member of all the subcommittees, but I want the committees to do the work and I will sit in with them and help if they need any assistance. But I don't anticipate that.

Mr. FULTON. Mr. Chairman, I have two suggestions.

The CHAIRMAN. Sure.

Mr. FULTON. I would have two suggestions: One is that we check and see on our scheduling of our authorization bill how it fits in with what the House Appropriations Committee already is doing.

The CHAIRMAN. I can tell you that.

Mr. FULTON. Will you tell us that?

The CHAIRMAN. They have already had the hearings on NASA. They have completed the hearings on the supplemental appropriation bill but not on fiscal 1961. They have not completed the hearings on the other features of the independent offices bill.

Mr. FULTON. When will that be coming out of the committee?

The CHAIRMAN. They don't know exactly, but since they have completed some hearings on NASA we are under pressure——

Mr. FULTON. That is what I am trying to get at.

The CHAIRMAN (continuing). To get the matter out. I am going to talk to the leadership today and tell them when we hope to get the bill out and ask them to—if they can—to make arrangements to take it up right away as soon as we get it back from the subcommittees and approved by the full committee.

Mr. FULTON. Now, the second suggestion, that if we are going to finish these posture hearings, which I hope you do, and then go into the hearings on the authorization bill for this current year for our committee, there are those of us serving on other committees—for example, I am on the House Foreign Affairs Committee and I must keep those duties up, too. I have a suggestion I am going to make. It then makes a limit on time and in Pennsylvania our primaries begin on February 23, the campaigns. So that we run through until April 26 with that in addition. Now, we have had other things on this committee that have been smaller in importance, but nevertheless time consuming to date. I don't complain about that. But I would make a strong suggestion that those things now be put aside because I understand that there is a proposed report on the Glennan hearings. Now, I must give notice of filing a minority report, if such a report is being prepared for the committee, and it will take much time for me to do that. My suggestion is that those——

The CHAIRMAN. The gentleman tells me he gets up, gets started at 4 in the morning.

Mr. FULTON. I do.

The CHAIRMAN. So that part doesn't worry me, the time you need.

Mr. FULTON. Not for the record.

(Discussion off the record.)

The CHAIRMAN. What chance does space have under those circumstances?

Mr. FULTON. I think you will find my attendance record is only second to the chairman on this committee.

Mr. HECHLER. Fulton for Vice President.

The CHAIRMAN. Well, that——

Mr. FULTON. You see, I don't want these other things coming up. I want that Glennan thing put off for awhile, or put off, period, because it is going to take time.

The CHAIRMAN. We are going to try to work with you fellows on both sides here, we are going to try to work it out.

Mr. FULTON. Do you have a calendar on that particular matter?

The CHAIRMAN. We don't have a calendar yet, but we will and we will give you some dates on it.

Mr. FULTON. I really feel it is an imposition to have us give our full attention here on this bill and to have these other things and then have things that may have a—I don't know—a political slant, likewise, that are on the side on hearings——

The CHAIRMAN. Mr. Fulton, this is a four-ring circus. You have been to Barnum & Bailey Circus. We can handle it in different rings. You go ahead. You will have time to work on a report. We don't want it too good, anyway. [Laughter.]

One more thing, that I think I could mention here in open session: I am working on a letter asking for the release of this $137 million that has been set aside there for the Zeus project. I am just going to ask that it be released to the agency that needs the money.

Mr. BASS. Mr. Chairman, is this your action or are you acting for the committee?

The CHAIRMAN. No; it is not at this time for approval of the committee. I just wanted the committee to know. I am trying to be frank and aboveboard.

Mr. FULTON. Shouldn't we have committee action on that?

The CHAIRMAN. It will be all right. Let me write my letter first and get that out of the way and then we will have some committee action. My thought is we will probably finish up 3 or 4 minutes early and then go into executive session. I have one matter I want to mention to the committee.

Now, this morning we have two distinguished witnesses with us and we are very happy to have Lt. Gen. Arthur G. Trudeau, Office of Chief of Research and Development, and Maj. Gen. W. W. Dick, Jr., Director of Special Weapons.

Now, in this posture hearings we have sworn all of the witnesses. So, do you, and each of you, solemnly swear the testimony you will give before this committee in matters now under consideration will be the truth, the whole truth and nothing but the truth, so help you God?

General TRUDEAU. I do.

General DICK. I do.

The CHAIRMAN. Have a seat. We welcome both of you to the committee. We know the fine work both of you have done and we know you are sincere and earnest and are willing and ready to help our committee.

Now, General Trudeau, you have got a statement and so does General Dick, but we will take yours up first, sir. If you will proceed, we will appreciate it.

STATEMENT OF LT. GEN. ARTHUR G. TRUDEAU, CHIEF, RESEARCH AND DEVELOPMENT, DEPARTMENT OF THE ARMY

General TRUDEAU. Thank you Mr. Chairman.

Members of the committee, I am Lt. Gen. Arthur G. Trudeau, Chief of Research and Development, Department of the Army. I want to express my appreciation to the committee in view of the pressure of time that has just been explained to this gathering for giving us time to present our side of the case this morning. I should like to report to you on the Army's research and development program and its contribution to the national space effort.

Secretary Brucker has reviewed for you the military potential of space and the Army's accomplishments in space. General Lemnitzer has outlined the Army's role and interest in space and the utilization of space to assist the Army in accomplishing its missions. My purpose today is to explain the philosophy of the Army research and development program and relate these to the national military space program as an extension of our experience, capabilities, and resources.

Now, I believe that it is essential to state that the research and development program is based on the Army's assigned combat functions, the assigned role in air defense, and the necessary supporting functions, such as worldwide logistics. From these missions we compute the research and development requirements which are influenced by three major factors: The future threat to the national security; the scope, nature, and shape of tactical organizations; and the sum of the advances in science and technology which can be made available. Over the past 185 years your Army has constructed a solid foundation of competence, resources, and capabilities that have steadily expanded and matured as the demands of warfare have progressed

from muskets and mules to rockets and missiles, and now to space technology. This research and development base is operated by the seven Army technical services: The Chemical Corps, the Corps of Engineers, the Ordinance Corps, the Medical Service, the Quartermaster Corps, the Signal Corps, and the Transportation Corps—all under the direction of my office for the Chief of Staff.

There is perhaps little apparent relation between the development of a semiautomatic rifle and the launching of the first U.S. satellite, or between the solving of the Panama Canal malaria problem and the successful transport of primates through space. But, however diverse these accomplishments may be in point of time and purpose, they are nonetheless the product of a single, timeless Army mission: to provide the U.S. Army with whatever support is required in its sphere of interest.

Let me mention a few specific examples of this technological capability. The Army presently owns and operates approximately $1 billion worth of research and development facilities. The research and development resources of the Army include approximately 40,000 personnel, with a high percentage of scientific and engineering talent capable of conducting and controlling the most advanced efforts in research and development. These personnel and facilities represent an annual operating expense of over $400 million, and are supported by an approximate three-fourths-billion-dollar effort from industry and private institutions.

Gentlemen, I reviewed a few of the aspects of this technological foundation or base for you because it serves to emphasize the resources with which we pursue our program. Our objective is to provide, on a continuing basis and as far as budgetary limitations permit, the most effective weapons systems and materiel for our Army, the other services as required, and for our allies.

The research and development program proceeds in two broad areas: The first is basic or fundamental research into the scientific disciplines; the second is applied research and development that results in hardware for the troops in the field.

Basic research looks into the future for a period of about 12 to 20 years, toward the battlefield of 1975, as an example. The Army is particularly aware of the essentiality of basic research because we believe it to be so crucial for significant future developments. We shall continue to stress it. Today we have almost 2,600 research tasks that cut across 16 major scientific disciplines and 74 subfields. This work is conducted at 52 Army installations, at 21 other Government agencies, and by over 550 colleges, universities, scientific research institutions, and private industrial contractors. Part of this program is conducted in 14 countries in Europe, and in Japan.

Applied research and development is concerned with the classic military fields of mobility, communications, firepower, support, and the soldier—or man—himself. And here we must take a shorter look into the future—say 5 to 8 years—and seek to fashion the machines of war necessary to combat the potential enemy of that time frame.

What we are developing and testing now is, of course, based on the fundamental discoveries and investigations of the last decade. I shall not choose to run down any extensive list of prospective new equipment except to mention a few of the outstanding examples.

These include aerial vehicles which utilize ducted fans on movable mountings, more versatile tanks, radios that are smaller but with more operating frequencies, a new family of missiles to replace or supplement conventional cannon, more compact and faster transportation of supplies and better protection for the soldier in the hostile environment of the nuclear battlefield. Of course, a major task, still, is the implementation of the innumerable improvements in weapons and equipment necessary to modernize the Army in every respect.

These are some of the challenging facets of the Army research and development program. I have given you a broad outline of our activities and some personal reflections about this effort, and I want to assure you that we will continue to pursue our program in a bold and aggressive manner with the backing of an understanding Congress and an enthusiastic Army, convinced of the importance of its mission for national defense.

ARMY CONTRIBUTIONS TO THE SPACE PROGRAM

I should like to outline for you the Army's participation, to date, in the national space program. The research and development program in the fields of Army interest that I have mentioned have provided an unusual amount of experience for conducting investigations, experiments, and in some cases for designing operational systems that utilize the medium of space, while contributing to our land combat mission. Rockets advanced from artillery, and missiles from rockets; data and computing techniques from the science of ballistics, the abacus, and the adding machine; precise electronic systems from Edison's light bulb and communications developments, and biological experiments; from the medical laboratory, the surgeon's scalpel, and basic research. This experience combined with high motivation and a unique capability insures an interesting, rich, and vital program for the future of America.

Let me emphasize what I mean by real experience in the missile and space field. First, any space effort, explorations, or space systems are based on rocket technology. Second, it is obvious today what can be done with a 5-year lead time in the missile business. Despite claims to the contrary, it has been the Army that vigorously pioneered rocket-missile technology for 10 crucial years after World War II. We used rockets in the Mexican War and in World War II, also. I would like to mention here that in 1942 the first rockets used by the Army were used at my instigation and they were Navy rockets and they were used by the Army over considerable objections at that time on the part of certain Army establishments.

The CHAIRMAN. You mean the Navy didn't want you to use them?

General TRUDEAU. No, sir, the Navy was very glad to give them to us. The resistance came from certain places in the Army.

We fired our first test ballistic missile in December of 1944 and 10 years later we had two guided missile systems in production and on station ready for employment by Army soldiers.

The next year, a Redstone inertially guided ballistic missile was successfully fired. These milestones are meaningful because, as additional accomplishments were accumulated by the Jupiter IRBM, the launching of Sputnik in October of 1957 created the emergency that

could be overcome only by a similar event. There was no rocket or missile capability in existence in the United States at that time that could launch an earth satellite except that of the Army. Consequently, at the first opportunity, after we were able to secure the authority, we did the job and were able to repeat it many times thereafter.

Just last year NASA programed five Moon probes; one of the Army's two probes passed relatively close to the Moon and is now in solar orbit, the first and only U.S. space probe to go into a solar orbit, to date.

These examples lend substance to the manner in which experience culminates in success. From the vantage point of foresight and real accomplishments, it is high on the credit side of the record that Army research, development, and organization have made major contributions to our national space effort to date. We only have to look to the future and Saturn to note this continuing major contribution.

I believe that it is important to realize that space must not be considered the property or province of any single national agency. Further, it will take the best efforts of all—scientific and technological institutions, industry, government, and the military services—to gain needed ascendency in this realm of national endeavor. All have several and often common interests in space. As a matter of fact, just recently it has been discovered that water vapor and certain types of atmospheres do surround some of the planets, and I would assume that there can be little argument about the fact that there may be plenty of real estate to explore and perhaps develop within our solar system and the universe as a new millennium approaches.

In addition, the planning that goes toward real and significant exploration of space, of the vast reaches of space, should closely resemble a national strategy, much like the conduct of international diplomacy, economic aid, or military security. We may find rewards in space that transcend those from the bowels of the earth.

As you well know, the Army since 1958 has conducted all of its space efforts under the National Aeronautics and Space Administration or the Advanced Research Projects Agency. Current projects were assigned and funded by these agencies and the resulting tasks were then integrated by the Department of Army and technical services into the overall research and development operations. Since the larger rocket boosters for the programs which require space flight are now the responsibility of the Air Force or NASA, the Army is concerned primarily with the payloads at present. These are the payoff of satellite or space programs, of course, and some of them that are presently programed may become an integral part of an assigned Army mission, like geodesy or communications. Consequently, we are vitally concerned with such means to assist our land combat responsibilities, and to the national effort, especially when we recognize that orbiting platforms often give us the best, and may provide the only opportunity to insure adequate measures for national security.

Let me describe the NASA and ARPA programs that the Army has been assigned.

The Army has supported NASA in several fields of endeavor since the latter's inception to include space probes, satellites, large thrust boosters such as Saturn, biological experiments, and support of the

Mercury program. In fiscal year 1959, NASA placed $28.5 million of requests and purchase orders with the Army, but in fiscal year 1960 to date only $10 million.

On January 31, we passed the second anniversary of the launching of Explorer I which is still up there and is estimated to have made more than 9,000 trips around the Earth for a total of over 280 million miles. Since that original effort, the Army has done considerable work for NASA on satellite and space probe launchings and the development of payloads. This includes the Pioneer IV lunar probe which passed the Moon and went into orbit around the Sun and the Explorer VII Earth satellite placed into orbit last October which has added to our knowledge of the radiation fields around the earth. NASA has requested the Army Ordnance Corps to launch five more scientific satellites this year. This task calls for the provision of the payloads as well as the launching of them. Another NASA sponsored satellite program is the payload for the Tiros meteorological satellite. The Army Signal Corps is working on the payloads with the assistance of the Radio Corporation of America.

A program much in the public eye these days is project Mercury. Eight Redstone missiles are being provided for launching capsules into ballistic trajectories commencing this spring. Besides the booster hardware and launching, the White Sands Missile Range in New Mexico is to man three tracking stations in this program and the Army Ordnance Corps is to provide for the participation of its down-range measurements ship.

Incidentally you probably saw that pictured in the Star last night. The American Mariner is the down-range ship and is equipped with new radar equipment that will be used in the South Atlantic in furtherance of tests like those in the short film that you saw yesterday.

NASA has also requested Army support in the form of a number of special studies. These have included such matters as lunar soft landings, aspects of celestial mechanics, reentry problems, and properties of materials. The Army Ordnance Corps was also requested to include limited biological experiments in rocket flights, and the Army Surgeon General to provide for biomedical experiments.

At this point I would like to mention briefly the Saturn program, although strictly speaking it is not yet a NASA program. Saturn, as you know, represents our earliest hope for a booster to match the Soviet capabilities. It was first proposed by the Army Ballistic Missile Agency almost 3 years ago and we are pleased to see that its value has been recognized today.

With respect to the programs with ARPA, the Army supported over $83 million in projects in fiscal year 1959 and over $90 million in fiscal year 1960, to date. Although many of these projects are classified, I should like to mention the general program areas. First, there is the Notus family of communications satellites. There is a critical need for faster and more reliable communications to relieve overloaded circuits. And this will have perhaps as much value for our commerce and industry as in future military operations. The Army is working on several satellite payloads and ground stations to solve this situation and to expand the global communications networks. The importance of the Army Courier communication satellite has already been mentioned to you by Dr. York and the first launching is

scheduled for May of this year. Space surveillance is another important area and several projects are being pursued toward satellite tracking capabilities for both known and unknown satellites under Project Shepherd. Space vehicle and missile defense systems seeking something more advanced than the Nike-Zeus system are being investigated under Defender. These systems are studies only at this time but they serve as a basic input into future weapon concepts needed for the decades ahead. This is, perhaps, the broadest project area that the Army is investigating for ARPA.

The last two areas, Principia and Pontus, are tasks in the field of solid propellent research and materials research. Both are important to the future advancement of rocket technology.

It is obvious, then, that the Army has ably supported the space programs of NASA and ARPA in as extensive a manner as authorized, and in doing so has had a very important, if not always well publicized, role in the Nation's space activities. A wide variety of Army organizations and associated civilian agencies have participated in this effort and a tremendous amount of experience has been gained in these scientific and technological fields. What is more important, our technological base has reached the most extensive proportions in history, such that even after the ABMA transfer of its Development Operations Division is completed, the Army will still retain a considerable space capability in the technical services and allied civilian organizations.

In summary, the Army's research and development program has a broad and comprehensive scope to produce the kind of weapons and materiel that land combat forces of the future will need to enforce our national policies and protect our national interests. With such a diversified program we have contributed substantially, and can continue to do so, to any national space program. Although it is difficult to lose any part of an efficient and dynamic organization, we do not intend to allow the transfer of the Development Operations Division of ABMA to hinder the accomplishment of new defense programs. In addition, we stand ready confidently to accept responsibility for additional tasks in the challenging space field because we realize that the immediate future cannot help but uncover new discoveries, benefits, and military advantages in this new and challenging dimension of our civilization. Our basic mission is still to maintain ascendancy in land combat; in any area that man can operate, anything in any medium that will further this task is of immediate and continuing concern. The utilization of space is definitely included in this category.

It took the Army 5 years to obtain initial recognition of the military potential of the airplane, more than 50 years ago. We have sensed the military potential of space since before we first put Explorer I into orbit. We think that in less than 5 years we will have been proven right. May I suggest that we determine this for ourselves now and not wait until we are under greater duress than exists today.

Gentlemen, I appreciate the privilege of appearing before this committee and the Army stands ready with all of its personnel and resources to keep you fully informed at all times. We will gladly try to answer any questions that you may have. Thank you very much.

The CHAIRMAN. General Trudeau, a magnificent statement there.

General TRUDEAU. Thank you, sir.

The CHAIRMAN. It does present the record of the Army and no one should be ashamed of that fine record. As a matter of fact, I am so impressed with your statement that I am going to place it in the Congressional Record, this morning.

General TRUDEAU. Thank you, sir.

The CHAIRMAN. Now, Gen. William W. Dick, Jr., Director of Special Weapons. We would like to have your statement next and we will ask for questions.

STATEMENT OF MAJ. GEN. WILLIAM W. DICK, JR., DIRECTOR OF SPECIAL WEAPONS, OFFICE OF THE CHIEF OF RESEARCH AND DEVELOPMENT, DEPARTMENT OF THE ARMY

General DICK. Mr. Chairman and members of the committee, I am Maj. Gen. William W. Dick, Jr., Director of Special Weapons, Office of the Chief of Research and Development, Department of the Army. My purpose today is to report to you on the status of Nike-Zeus. My comments will be made on an unclassified basis and so my opening statement will be necessarily brief.

The Nike-Zeus is designed to defend against the ballistic missile threat—to include both the intercontinental ballistic missile and the shorter range, intermediate and submarine-launched ballistic missiles. It is the only weapons system of its type under active development. The same experienced Army-contractor team, which has successfully developed other Army air defense weapon systems, is being utilized on the Nike-Zeus.

The German V-2's in World War II provided a preview of the ballistic missile threat. Subsequently, the Stillwell Board in 1946 recognized the magnitude of the threat posed by the ballistic missile married to a nuclear warhead and recommended development of a defensive system to combat it.

It was not until 1955, however, when the Army initiated feasibility studies at the Bell Telephone Laboratories followed in 1956 by component development and experimental work, that active effort began on Nike-Zeus.

Since that time the development of Nike-Zeus has been conducted in accord with a logical and orderly plan, consistent with the urgency and priority assigned to the program. This plan calls for an early system test to be conducted at White Sands Missile Range and later a full systems test at Kwajalein Island against actual IRBM and ICBM targets.

The development program milestones necessary to fulfill this test plan have been achieved on the scheduled set some 2 years ago. Construction of the prototype installation at White Sands is nearing completion. Hardware has been built and is being tested. Early missile performance flight tests are underway and several test missiles have been fired to date. Construction of the Kwajalein site is also underway.

Subsequent to my last appearance before this committee, it has been possible to demonstrate the growth potential which is inherent in the design of Zeus by incorporating changes in the system which improve

significantly the design performance without the necessity to slip the program schedules. These changes include higher power and more sensitive radars of greater range and an improved missile. Research to increase further the Zeus capabilities and effectiveness is being conducted.

The Zeus is the pioneer defensive weapon development project of the ballistic missile age—a pioneer of qualified heritage and background, our previous Nike family experience. It has no immediate competitors.

At this point I would like to explain more explicitly what I mean by that last statement. There are two principal means of defense against any weapon system: passive and active. Passive defense denotes the measures taken for protection against a weapon system. In the case of ballistic missile defense, this would mean underground shelters, organization for civilian defense, and protection against the effects of a nuclear explosion.

On the other hand, active defense means the measures taken to defeat a weapon system. This would be the means employed to destroy a ballistic missile before it reaches a target.

At the present time there are several programs and projects designed to contribute toward an effective ballistic missile defense. These consist of warning networks, tracking systems, an active defense, antiballistic missile weapon systems, and many study programs for advanced ballistic missile and space vehicle defense.

For instance, the BMEWS radar warning network and the Midas detection satellite will furnish valuable information, in the future, so that we can prepare ourselves for a possible missile attack.

These systems are not now in operation but it is anticipated that they will be part of a vast warning network in the years to come. These systems contribute no active defense against an ICBM. In other words, they will only give the alarm.

The only active defense system that the Nation has under development now is Nike-Zeus. There are many studies, concepts, and proposals but no other means of attacking an ICBM in flight on the way to a target in the United States is under development. That is why the Army is so vitally interested in pursuing what we believe to be the only active antimissile defense system which could give us a reasonably early capability to meet the recognized Soviet ICBM threat.

Progress made in the program to date gives me no reason to doubt the successful development of the system and has reaffirmed the Army's confidence in Nike-Zeus. The Army believes that the Zeus has the capability of advancing with the ballistic missile threat. This growth potential is made possible by the use of a flexible design capable of ready modification to accept new data or new techniques as furnished from the research program.

Gentlemen, it has been a privilege to appear here before you again. I shall be happy to answer any questions, as I am able to, on an unclassified basis. Thank you very much.

The CHAIRMAN. Thank you very much, General Dick, for an excellent statement.

Now, this committee operates under the 5-minute rule. We will invoke it this morning. We are going to absolutely run it on a 5-minute rule, including the chairman.

I want to ask you, General Trudeau and General Dick, both of you: The $137 million which was approved by Congress for the fiscal year 1960 is being withheld. Who is withholding that money?

General TRUDEAU. The $137 million appropriated by the Congress for the current fiscal year was for preproduction engineering which is a different item than research and development, itself, and was to permit the construction of certain equipment that would expedite production of the missile if it was so authorized.

These funds are being withheld, as far as we are concerned, by the Department of Defense. Whether it goes higher than that or not is not known to me.

The CHAIRMAN. The Department of Defense has the money now, though?

General TRUDEAU. That is correct.

The CHAIRMAN. Now, if that money is released, the natural result would be your preengineering plans; that is correct, isn't it?

General TRUDEAU. That is correct.

The CHAIRMAN. And if the Zeus continues to program in research and development, as it has in the past, you would want to go ahead with that at once; is that correct?

General TRUDEAU. We feel that way. There are others who don't agree with us, but we have that confidence in the system; yes sir.

The CHAIRMAN. Well, we have nothing else to pin our hopes to but the development of the Zeus program to bring down missiles; isn't that right?

General TRUDEAU. That is correct. It is the only thing in the foreseeable future, say to 1970, that can possibly do this job.

The CHAIRMAN. Dr. York testified before this committee a year ago, a year and a half ago, that the Zeus system might cost around $15 billion.

General TRUDEAU. I think that figure has been reduced to about 9 to 10, now.

General DICK. Seven and one-half.

General TRUDEAU. Seven and one-half billion is the figure.

The CHAIRMAN. Seven and one-half. If we continue to work on it, it might come down even lower than that, maybe, but 7½ billion is your present figure?

General TRUDEAU. That is conceivable. But if it is needed for this country and if we are going to stand out with the Russians in a nuclear hailstorm, then the fellow that can have an umbrella over his head is going to have quite an advantage.

The CHAIRMAN. Now, the withholding of $137 million now is having what effect on the program?

General TRUDEAU. You might say on the research and development program it is not having any effect, but if the research and development program progresses to a point where they say "go into production," then there will be time lost if we are not able to conduct some, and preferably as much as possible, of this preproduction engineering.

To give you an example, I have in my hand here a model of transistors, resistors, and other very small electronic parts which I would like to pass around.

Would you pass one down either side? They are the little items that you see in there. In this one you will note flecks of metal that are

about six-thousandths of an inch square and a thousandth of an inch thick.

Each of these little items do the same job as a large radio tube with which you have been familiar, and it takes millions of them in the Zeus system. To prefabricate these items now, individuals—to a large extent women—work under microscopes because the work is so intense and the particles are so minute, at a cost of perhaps $20 to $50 apiece.

Now, in the numbers we are getting into, it is necessary that we develop the equipment for automated lines with a high degree of reliability for its product. It is for doing this work and advancing this field and cutting this terrific leadtime with which we are faced that we are trying to get a substantial portion of the $137 million, for instance.

The CHAIRMAN. If you got the $137 million released to you today, how much time would it save in the overall program of developing and engineering this Zeus missile?

General TRUDEAU. What have we used? Six to nine months is the statement of General Dick, if you go into production. Now, I might say with respect to all of these new electronic components—and we have had tremendous advancements in this field as the field continues to accelerate in the technological breakthroughs we are getting—that these will also have a real application in all space efforts, no matter who does it.

This is not just for Zeus. This is a breakthrough and a development for which we have got to have automated machinery in this country, no matter whether Zeus ever is built or not.

The CHAIRMAN. So that the 137 million if spent for engineering, the results would be available for the whole space program and would be usable; is that what you are saying?

General TRUDEAU. I would say that for a substantial portion of it, this would be true. There is some of it that goes into more advanced work that does involve some brick and mortar in connection with pilot lines and new plants. But not all of it. If some of it probably did go into Zeus production, you can say it would be lost or used in the interest of trying to develop this automation and save time for development.

The CHAIRMAN. What percentage would you say?

General TRUDEAU. Dr. Morse, in consultation here, just mentioned that a letter has gone to the Director of Research and Engineering, Dr. York, in the Department of Defense, requesting especially the release of $25 million to get into the pilot lines and the pilot equipment for producing this very intricate electronic equipment.

The CHAIRMAN. I hope you get it, General.

General TRUDEAU. Thank you, sir.

The CHAIRMAN. Mr. Fulton.

Mr. FULTON. Very glad to have you here and I think both of your statements are excellent. The question, of course, is one of what is the cutoff point? What is the cutoff point on the research and development program of the Nike-Zeus? Some of us that had experience on the aircraft scheduling unit in World War II always had the problem of when you cut it off and put it into production.

General TRUDEAU. That is right; that is always a problem.

Mr. FULTON. What generation it is and how competent it is. Now nobody at this particular stage says that the Nike-Zeus will be 100

percent foolproof, nor are we sure, in operation, that it will defend us, maybe, on these three proposed installations, more than an arc of maybe 60 percent around the country. It doesn't even go 60 percent.

Under those circumstances, it is then a judgment that is not political but one of engineering and it has been adequately handled, to me, by Dr. York, the Director of Research and Engineering, Department of Defense, as well as with your research and development program.

So I would like to compliment both you and Dr. York on your research and development on the Nike-Zeus, because it is given the highest priority on Government programs by the administration and by the Defense Department as well as the Army.

Already you have saved, and you corroborate this, within about 15 to 18 months that this has been under discussion, by going ahead with the research and development program, the original estimates for the cost of the Nike-Zeus have come down from $15 to $7½ billion, is that not right?

General TRUDEAU. No, it is not right, sir. If I may add to that, there is probably a billion and a half dollars that is going into research. So if you talk about the whole thing as a program, the figure would be around $9 billion.

Mr. FULTON. I think you are correct. But you have through your efforts, as well as with Dr. York's direction, saved approximately then $6 billion through going ahead with the research and development program?

General TRUDEAU. I would like to qualify that again, if I may, Mr. Fulton, because a part of this savings appears in the interest of getting something for the country, a system that would meet minimum requirements at least. We have considerably reduced the number of weapons or batteries on site that was contemplated under the $15 billion program.

Mr. FULTON. But the problem is there as to coming up with a level of efficiency of Nike-Zeus, that we can be standing under the apple tree with our apron out and maybe catching 29 out of 30 apples and missing the 30th, and it hits us on the head.

Now, therefore, if we are trying——

General TRUDEAU. Well that is not a bad ratio. I'd bet on that.

Mr. FULTON. If we want to step up the ability of Nike-Zeus, maybe you had better go ahead and do more R. & D. Don't you think more research and development work is necessary before it becomes operational?

General TRUDEAU. There is no question about that; we admit that. We would like to proceed at the most rapid pace. I can only say—and I would like to say—that there are several other weapons systems, some of which are or will be obsolete, that have cost more in their entirety to date than is predicted for the Nike-Zeus; and they have been adopted without so many difficulties. If we were to take the philosophy in research and development that we couldn't go ahead until it is proven, then we should eliminate research and development.

Mr. FULTON. Yes, but when you have a weapons program with 50 different projects in it——

General TRUDEAU. And no potential before 1970.

Mr. FULTON. Well the so-called—I am not allowed to say that.

The CHAIRMAN. The gentleman's time expired.

Mr. FULTON. Not quite, sir. I looked; it was 16½ minutes when I started.

Mr. SISK. Point of order. I think the chairman is determining the time here and we are going to have to depend on the chairman.

The CHAIRMAN. I am doing the best I can. The gentleman's time has expired.

Mr. TEAGUE. Mr. Chairman, can I yield the gentleman 1 minute?

The CHAIRMAN. No; you can't.

Mr. FULTON. Would you yield for a comment?

Mr. TEAGUE. If possible.

The CHAIRMAN. Well, you can yield for a question.

Mr. FULTON. I am always appreciative of the various services claiming the "firsts" in the ballistic missile field and in the use of science on these programs, but I would like to point out to you that the first use of ballistic missiles was in the Third Macedonian War, ballistae were used by Perseus to very great strategic advantage, and likewise the Moon was used as a satellite——

The CHAIRMAN. The gentleman's time—Mr. Teague's time is now about to expire. [Laughter.]

Mr. TEAGUE. I ask unanimous consent that he be able to extend his remarks in the record.

Mr. FULTON. Thank you. [Laughter.]

Mr. TEAGUE. General, what is your opinion of the efficiency of our Government in using the capabilities of our country? I ask you that because we go around these companies and visit them, and invariably they come around to saying that it takes almost as long to get a contract going as it does to get them to complete the job, that they want us to do.

General TRUDEAU. Well, our system is complicated, I will say that. I think we do a fair job of operating under the system. One of our great problems in this country is the leadtime where it takes us from zero up to 10 years to bring anything from concept to production. The Russians are able to do it in half the time.

This is due to the safeguards inherent in our system, the same as the congressional hearings which you go through here, which may be time consuming but are necessary safeguards.

I don't want to criticize the system, but I think there are improvements that can be made. I think the American system has to learn to do things faster between concept and delivery, if you will.

Mr. TEAGUE. We get the criticism that it is necessary to rotate your people: you send a new man in and it takes him a year to get acquainted with what is going on.

General TRUDEAU. That is true; there is some degree of rotation. On the other hand, it is desirable to bring fresh brains in on these problems, as we have found there is nothing worse than an old line outfit which hasn't had a change in management for 20 years.

Mr. TEAGUE. That is all.

The CHAIRMAN. Mr. Bass?

Mr. BASS. You indicated that you disagree with other authorities and believe that this $137 million should be released and that you should be allowed to spend it, I believe you say, on preproduction engineering?

General TRUDEAU. I don't think I have stated it quite that way. I have definitely stated that we do believe that at least $25 million initially should be released right now to progress in these fields that I pointed out. We do say that, if the rest were released, it would result in a savings of time between now and the time we get to overall production.

We can recognize the fact that perhaps scientific brains better than ours have serious doubts about this and are justified in withholding it. We accept this. This is part of the system.

We don't have to be happy about it, but we accept it just like a lot of other things.

Mr. BASS. Do you think it should or shouldn't be released?

General TRUDEAU. I think it should be released; yes. I think we should go full blast, personally. This represents my confidence in the program which isn't shared in full by Dr. York and some of his associates.

Mr. BASS. Yet, as I understand it, this Nike-Zeus system has not been fully proved out; is that correct?

General TRUDEAU. This is perfectly true, but if we had taken this same premise, there are lots of other systems that would never have gotten off the ground; and it might have been better if some of them hadn't, I will admit. [Laughter.]

Mr. BASS. Mr. Chairman, I would hope that before this committee makes any statement or recommendation on this Nike-Zeus system that we at least give those who disagree with General Trudeau an opportunity to present their case before this committee.

As I understand it, Dr. York does not agree and I assume also Secretary Gates and General Twining, because they have——

The CHAIRMAN. Will the gentleman yield? But the Congress has felt like it should be spent there, and we put up the money after it has been proven to us.

Mr. BASS. Well, just speaking for myself, I don't necessarily go along with that. I would like to hear both sides of the case, and I think it is a hasty and ill-advised action to go ahead on this, just having heard one side of the case. That is all I have to say.

The CHAIRMAN. Any further questions. If not, Mr. Anfuso.

Mr. ANFUSO. General, first of all, I want to congratulate you for your sincerity and your fighting spirit. I think that is just what we need in these times.

General TRUDEAU. Well, you pay a price for it, sometimes.

Mr. ANFUSO. Well, I am sure you are willing to pay that price.

General TRUDEAU. That is right.

Mr. ANFUSO. I was very much interested in this umbrella that you spoke about.

Now, if we had this umbrella, wouldn't we automatically bring about a reduction in armaments, particularly in the manufacture of ICBM's and IRBM's? In other words, if we had this protection, both sides would realize: Well, what is the purpose, what is the sense of manufacturing more ICBM's or IRBM's, they can't penetrate anyway?

General TRUDEAU. That could conceivably be true, but what causes even more concern in my mind is what position it puts the other fellow in with respect to blackmail, threats—pick your own word for it—if

he has this umbrella and felt confident that he could block the majority of our retaliatory effort against him, and we were naked.

Mr. ANFUSO. That is right. If we had this umbrella we certainly would greatly discourage the enemy from going ahead full blast on this threat of bombing us out, and Khrushchev has said that many times that he could ruin this country.

General TRUDEAU. I think there are many psychopolitical aspects to it.

Mr. ANFUSO. Now, you said that 3 years ago you proposed—rather the Army proposed going ahead with the Saturn. What stopped you?

General TRUDEAU. Well, there was no funding or no approval for it at the time.

Mr. ANFUSO. Although funding was requested?

General TRUDEAU. Well, yes; the project was submitted with a view to having funds made available for it. It is a natural breakout from our Jupiter engine. It is merely a cluster of engines to give us something that would be the equivalent of anything Russia has used today as a booster.

Mr. ANFUSO. Now, if you had this money to go ahead with this engineering project which you say is absolutely essential, of course, you would want to continue research just the same, research and development would continue, isn't that right?

General TRUDEAU. They are related.

Mr. ANFUSO. They are related.

General TRUDEAU. They are related projects. One of the things we do in most of our systems, particularly where we feel any confidence in them at all, is to do what you call the preproduction engineering: the tooling up or development of the equipment as early in the program as possible to cut down this terrible time between the concept of an idea and the production of the finished equipment. It is really too great, much too great, today.

Mr. ANFUSO. With an ICBM going at the rate of 4 miles per second, it would take only 15 minutes to travel 3,400 miles, which would be sufficient to bomb out New York City, in which I am vitally concerned. We heard here about a 15-minute warning.

I don't think we would even have that with an ICBM, would we?

General TRUDEAU. If BMEWS is operating, you would have it; but whether you had the full 15 minutes or not, we believe there is the capability being built into Zeus to operate in much less time.

Mr. ANFUSO. There is nothing you could do about it in 10 or even 15 minutes.

General TRUDEAU. Yes; there is, with Zeus.

Mr. ANFUSO. With Zeus?

General TRUDEAU. Yes.

Mr. ANFUSO. I am just talking about the warning system. There is nothing we have without Zeus——

General TRUDEAU. Even if you had the warning, what would you do? You would have no passive defense, and you would have no active defense.

Mr. ANFUSO. One final question: Yesterday afternoon I attended a symposium on this subject, and I was very much impressed with the testimony of yesterday on the Nike-Zeus and I asked some questions

and somebody said: "Well, perhaps the objection to that is that when it is perfected, 4 or 5 years from now"—1970, did you say?

General TRUDEAU. Oh, no; much before that, if we get the full go-ahead.

Mr. ANFUSO (continuing). "It might be outdated." Do you foresee that?

General TRUDEAU. No; I don't foresee that. As a matter of fact, we think it has the added capability of an antisatellite missile.

Mr. ANFUSO. Congress is very much concerned, as the chairman has said, about this project, and I think we all are. Would you be willing to sit down with your dissenters before a secret session of this committee and have it out and then finally we would—if we see fit, we would make the recommendation to the American people and to the Congress?

General TRUDEAU. I am always available to give the best and most honest information I have to the Congress.

Mr. ANFUSO. That is all.

The CHAIRMAN. Mr. Riehlman?

Mr. RIEHLMAN. General, did I read into your statement here this morning that you had any opposition to the transferring of the Von Braun team to NASA?

General TRUDEAU. Well, I would be frank to say, since you have asked my personal opinion on it, that I was not in favor of the transfer. Since it was decided by higher authority, we are endeavoring to do it in the most effective manner, as far as the national interest is concerned, and to minimize any delay or setbacks in our program in the meantime.

Mr. RIEHLMAN. Well, could you tell us briefly why you were opposing it? On what basis?

General TRUDEAU. Because we feel that there are real military problems, military potential in space; and we felt—at least I felt—I should speak for myself here—that there should be a coordinated effort, an agency within the Department of Defense that would do most of this work.

Actually, the development of the airplane in this country, both in World War I and World War II and for commercial use, was headed up by the efforts of the Army and the Army Air Corps under it. This combination succeeded in winning two wars and in building a great industry; and I sometimes ask myself whether this would have been the case with industry if NACA had had the primary interest and the military interests had been subjugated.

Mr. RIEHLMAN. Well, at the present time the development of Saturn is still under the direction of the Army, is it not?

General TRUDEAU. It is an ARPA program. It is funded by ARPA, but we are doing it under the Von Braun team. This is right, sir.

Mr. RIEHLMAN. And you will continue until the transfer is made——

General TRUDEAU. It will physically move over with Dr. von Braun's team to NASA.

Mr. RIEHLMAN. Do you have any fears that when it moves over, this program is going to be stymied in any respect, it isn't going to advance as well as it had under the direction of the Army?

General TRUDEAU. We are not going to let it, because it will be during a transition period and the full facilities of the Army, countrywide, are going to be behind this effort.

Mr. RIEHLMAN. Have you had any indication at all from NASA that you aren't going to have that type of cooperation?

General TRUDEAU. Well, the cooperation is going to be on our part. We are giving it to them.

Mr. RIEHLMAN. I mean after it is transferred? It certainly isn't going to be completed by July 1.

General TRUDEAU. The cooperation is on our part.

Mr. RIEHLMAN. I see, because you are handling the program under the direction of NASA?

General TRUDEAU. Yes; but let me make my point. After July 1 it will be a NASA program. If there is any cooperating to be done, it will be the Army that will be doing it, and we intend to do it.

Mr. RIEHLMAN. All right; you intend to give them full cooperation?

General TRUDEAU. Absolutely, no question about that. We must have Saturn as early as possible.

Mr. RIEHLMAN. That is all I have.

The CHAIRMAN. Mr. Sisk?

Mr. SISK. Thank you, Mr. Chairman.

General Trudeau, I am very much impressed with your statement; particularly, I think your answers to my colleague, Mr. Riehlman, were rather significant.

The Army has been seemingly one of the only branches that have for over a period of time really recognized the real need for superbooster vehicles and for some application of space as a military vehicle or for military usage.

Would you agree with that statement?

General TRUDEAU. Well——

Mr. SISK. I am not trying to start an interservice argument here. I am merely, as I say, I have been much impressed with this.

General TRUDEAU. I wouldn't go so far as to say the recognition of our talents are unique. But I do say what we have done speaks for itself.

Mr. SISK. I think you have done an outstanding job.

General TRUDEAU. Thank you very much.

Mr. SISK. I, for one, am appreciative of it. I want to get back to seemingly the No. 1 question, of course, that is being discussed, Nike-Zeus. I have been interested along with many others in this because I think nothing could be more valuable than a defense against a ballistic missile if it could be developed.

Now, on this engineering production money which, as I understand, we are talking primarily about the $137 million, I would like your frank comments on the status, for example, of a couple of other programs which I understand engineering production has been permitted.

That is on Polaris and Titan. Now, having some general knowledge of the background of Nike-Zeus and the length of time that you have worked on it, in the research and development program, I would like to have you comment on what you feel to be the relative status of research and development of these two weapons systems, Titan and Polaris, as compared to Nike-Zeus.

Here again, I am not trying to attempt to create any interservice rivalry, but I have a feeling that the Zeus in many instances was well ahead of some of the things on the Titan, for example. Yet they have been given the money, chances are being taken, the gamble is being made in these instances and yet apparently there is a hesitancy to take the gamble on Nike-Zeus.

General TRUDEAU. I have to say this in all honesty, that we have not brought a Zeus missile to the point where it is as complete or as near the finished product as is either Polaris or Titan. They have fired full-scale, according to my belief. I am not extremely knowledgeable about Polaris, but they have fired their full-scale missiles.

The results are another problem here. We have not fired a full-scale Zeus. We have had our fourth firing and it has been eminently successful, proving out everything that we wanted to prove. But each of these test firings, and they will number up into 30, 50, I don't know how many, adds some other new component that is being checked out to be sure that the whole and final package works properly. We are still a year to 18 months away from that, at least.

Mr. SISK. Of course, I am a stanch supporter of the Polaris program. I want to see them push ahead on that because I think it offers a real defensive weapon for us in the sense it is a good offensive program, but at the same time, I know they have been given the go-ahead so far as production is concerned.

In view of the progress that has been made in Nike-Zeus, of course, I for one, have been vigorously supporting the release of these funds to you people to boom ahead full speed, and I have some really serious regrets that that has not been done. Let me ask you if after listening to this for several days, isn't actually what we are confronted with now is the necessity of a decision?

Isn't actually a decision awaiting to be made somewhere as to the direction you are going?

I realize you still have some research and development going on.

General TRUDEAU. A lot of it.

Mr. SISK. But if we are going to boom ahead full-speed on Nike-Zeus, isn't a decision desperately needed and needed shortly on what we are going to do in the production field?

General TRUDEAU. This is correct, and the reason it is not forthcoming is because there are these differences in scientific opinion between other scientists and our scientists. I do not profess to be one of the great scientists, myself.

Mr. SISK. I certainly am not, either, and I hesitate to question any of the scientists, yet it seems to me that somewhere a decision is desperately needed when, so far as I know, all the testimony indicates that this is the only possible defense we have in the mill against the ballistic missile.

General TRUDEAU. I can only say that I know no other weapons system to which there have been as many strenuous objections. I have seen a lot of them that have gone forward when there were probably more scientific objections that could have been made to them than is the case in Nike-Zeus.

The CHAIRMAN. The gentleman's time has expired.

Mr. Mitchell?

Mr. MITCHELL. General Trudeau and General Dick, let me say this to you, that every member of the committee is intimately familiar with the pros and cons about Nike-Zeus.

General TRUDEAU. Yes, sir.

Mr. MITCHELL. I can say for myself that I have a very definite opinion as to what we should do and I am in full accord with both of you as to what should be done about Nike-Zeus.

Now let me ask each of you: Do you think that we can at this stage afford to gamble on Nike-Zeus in that we will not go as you term it, full blast?

General TRUDEAU. Well, I will put it this way: I think an active defense, if it is possible—and we think it is possible with Zeus—that will create a greatly added deterrent as far as Russian attack is concerned, and a very considerable but never complete ability to stop such an attack, if it were launched, is so important that we can't afford not to develop it.

Mr. MITCHELL. I agree with you wholeheartedly. Are those your sentiments, General Dick?

General DICK. I would say, Mr. Mitchell, in my personal opinion, the gamble is too large to take.

General TRUDEAU. To what?

General DICK. Not to go into production.

The CHAIRMAN. Not to go ahead, he means.

General TRUDEAU. Not to go ahead. [Laughter.]

General DICK. We have to have a little excitement here this morning, somewhere.

Mr. MITCHELL. Let the record show that emphatically, Mr. Chairman. [Laughter.]

General Trudeau, you mentioned something about the controversy between scientists as being the cause of the withholding of funds. Well, I submit that it goes beyond that and I think it is a prime example, the withholding of funds for the Zeus system is a prime example of the fact that we have not determined to make the maximum defense effort and that we are putting budgetary considerations above defense, itself.

General TRUDEAU. Well, I wouldn't want to impugn the motives of anyone, of course.

Mr. MITCHELL. That was my statement, General. I didn't ask for an answer. [Laughter.]

General TRUDEAU. OK.

Mr. MITCHELL. Let us turn now to Saturn. Do you think the transfer of Saturn to NASA will speed up the development of the project?

General TRUDEAU. No.

Mr. MITCHELL. Do you think——

General TRUDEAU. Unless they can put a lot more money behind it than has been made available.

Mr. MITCHELL. I am talking about funding as it was.

General TRUDEAU. From a technical standpoint; no.

Mr. MITCHELL. Do you think by virtue of the transfer that the cost of the project would be reduced or will it cost us more money?

General TRUDEAU. It is the same team. I wouldn't know. I don't see how it can be reduced.

Mr. MITCHELL. Do you think it possibly may cost more money?

General TRUDEAU. It could conceivably, because they are going to have to set up an administrative and logistics setup, which we have nationwide, to do all the servicing that is necessary. In the meantime, the Army is going to do this for them because we can't permit any slack. But it isn't just a question of acquiring the Von Braun team, because they are scientists and they shouldn't be diverted to have to go out and buy the hardware that is needed. We have done that in other parts. Von Braun has never had to worry about anything except concentrating on his scientific effort. The Army, through the Ordnance, the Engineers, and the Signal Corps has done all of the work to see that he has had what he wanted, when he wanted it, and where he wanted it.

Now, I don't know if the NASA establishment, countrywide, is set up to do this, but they are going to have to in time.

Mr. MITCHELL. Can you see any good coming at this particular time from the transfer of Saturn to NASA?

General TRUDEAU. Well, my answer, frankly, is, from a technical standpoint, no.

Mr. MITCHELL. From a practical standpoint?

General TRUDEAU. Well, you get into a lot of other points about the——

Mr. MITCHELL. Funding——

General TRUDEAU. Diplomatic status, diplomatic approaches, the psychopolitical values of where this should be or that should be, which I am not really qualified to discuss.

Mr. MITCHELL. Thank you, General.

The CHAIRMAN. Mr. Karth?

Mr. KARTH. Has Mr. Riehlman had his?

The CHAIRMAN. Yes.

Mr. KARTH. General, I want to compliment you on one of the fightingest presentations we have had before this committee and for the courage to express your own convictions upon being interrogated by the committee. I think a little more of this would probably help the committee make up their minds as to what they should do. I want to congratulate you on it.

General TRUDEAU. Thank you, sir.

Mr. KARTH. What does the transfer of the Von Braun team really mean to the Army in the R. & D. field? Will this have any serious effects on an overall basis to your R. & D. program, General? That is my question.

General TRUDEAU. We will still have a considerable competency in space and, of course, we will have less use for it with all of these various items and projects being taken away and being given to other services. The main thing we wanted was to be sure that the Von Braun team would not be dissipated, because we do consider it the greatest national asset we have with respect to space. I will not back away on that, no matter what other service or other agency is involved. The Army's one effort was to see that this great national asset was not dissipated. So we much preferred to see it go to any other service or agency than to see it disbanded. I wouldn't be truthful if I didn't tell you that after having built it and utilized it for 15 years, it was not a happy moment when we surrendered it.

Mr. KARTH. General, would you recommend a Manhattan-type project for the space program?

General TRUDEAU. Well, when you say a Manhattan-type project in that case you gave the Army complete authority to go ahead and get done what the country thought needed to be done. If the powers that be thought that there were certain things in this connection with respect to our defense, with respect to our exploration of space, which needed to be done, in the most effective manner and in the shortest possible time, the concept of a Manhattan project would have great value.

The CHAIRMAN. Any further questions?

Mr. KARTH. Just one other, Mr. Chairman. I would like to have the general, if he would, in regard to a statement on page 9 where he said space vehicle and missile defense systems more advanced than the Nike-Zeus system are being investigated under Defender. If you will elaborate on that——

General TRUDEAU. I can't say much in open session here. But there are research funds in which we are cooperating with ARPA in which different approaches are being sought. Now, these might involve propulsion of our own missiles or detection of the other missile or different "kill" means, or any or all of those three things. This is about as far as I can go. I assure you they are in the very initial stages and we see nothing there that would give us any promise of being in action within 5 years at least from the time that Zeus could be on station.

Mr. KARTH. Thank you, sir.

The CHAIRMAN. Mr. Hechler?

Mr. HECHLER. General Trudeau, you used on a couple of occasions the word "psychopolitical," which I think is a wonderful word. Can you give me about a 30-second thumbnail sketch of what you mean on page 11 of your statement that, "We determine this for ourselves now and not wait until we are under greater duress than exists today"? What do you mean by "duress today"?

General TRUDEAU. Pressure from the Kremlin.

Mr. HECHLER. I see.

Mr. ANFUSO. That is less than 30 seconds.

Mr. HECHLER. Now going back to page 6 of your statement you mention it will take the best efforts of all—scientific and technological institutions, industry, Government, and military services—to gain needed ascendancy in this realm of national endeavor.

Would you add, also, aside from those factors an understanding and a sense of urgency on the part of the American people? Do you think that would help any?

General TRUDEAU. I certainly would like to add that. I would like to say, as I happened to mention on the west coast the other day, that while I recognize the importance of the question—this is one I am not capable of getting into—the question of the missile gap, that I think we ought to also be concerned with the muscle gap which is your Army's capabilities—the hard core for sustained fighting—and also the mental gap. I think the mental gap needs a lot of attention in this country. I think we have gotten to a point where we can't differentiate between our standard of living and our way of life, and we are going to lose both unless we wake up.

Mr. HECHLER. Now, on page 5 I would like to most respectfully differ with a statement that you made here concerning the effect of a

launching of Sputnik. You said, "The launching of Sputnik in October of 1957 created the emergency that could be overcome only by a similar event." I would like to challenge that statement because the President himself said, immediately after the launching of Sputnik, "So far as the satellite itself is concerned that does not raise my apprehensions, not one iota."

Now, wouldn't your own job be much easier if the American people were awakened to the fact that we are facing really the gravest crisis in American history and it is necessary for the people to devote every ounce of heart, and mind, and muscle in order to meet that crisis? Wouldn't that make your own job much easier?

General TRUDEAU. It certainly would. I might say that when Sputnik was launched, I was the American commander of the I Corps in Korea and I had no knowledge that I was coming back to the country at that time. I got some consolation out of the fact that Sputnik had finally gone up, since I was pretty sure it was going up. Somebody was going to get up there soon and I felt sure it would awaken the American people, and it did. I was still in Korea when Explorer I went up on the 31st of January 1958 and I came back shortly thereafter. I thought surely I would find an awakened America to what the real problem was, long range, vis-a-vis the threat of world communism. I got back and at first I was impressed in talking with people that there had been some awakening. But only a little time had gone by when they were completely complacent and when the country club and corner drugstore seemed to solve most of their problems.

Mr. HECHLER. I must confess I agree with you. I want to shift quickly to General Dick, on the question of Nike-Zeus. I am very much impressed with your discussion of the fine family background of Nike-Zeus. I am sort of a nut on genealogy, too. I suppose you could say that unlike the Army mule that Nike-Zeus has both pride of ancestry and hope of progeny?

General DICK. I think that is very apt, Mr. Hechler. [Laughter.]

The CHAIRMAN. Mr. Daddario?

Mr. DADDARIO. If the Nike-Zeus system were completely operative today and there was a missile attack launched on, let's say New York City——

General TRUDEAU. And there was?

Mr. DADDARIO. There was.

General TRUDEAU. Yes.

Mr. DADDARIO. Under what conditions would the Nike-Zeus pick up the attack, and under what conditions would it destroy the oncoming missile?

General TRUDEAU. I would have to answer that in closed session, Mr. Daddario.

Mr. DADDARIO. Well, the reason I ask the question is that over the weekend you took very good care of New York, you were quoted as saying that it would be better to have an explosion 100 miles over Hartford, Conn., which I represent [laughter]——

General TRUDEAU. I would love to respond to that.

Mr. DADDARIO. Than a large explosion in New York City.

General TRUDEAU. I would like to respond to that. But I said a small explosion over Hartford, didn't I?

Mr. DADDARIO. Yes; I quoted that.

General TRUDEAU. First, I had regrets that I had named places, but later I was very glad that I did because I would like to drive the point home.

Mr. DADDARIO. It is insurance for New York City——

General TRUDEAU. What I am trying to tell you is this: that the very small warhead in a Nike-Zeus will destroy the big incoming warhead without a nuclear explosion; that the small atomic warhead is the only thing that explodes up there, and that there will be no damage to people 100 miles below it, unless the individual was specifically looking at that point at that time. This is very important.

Mr. DADDARIO. That, of course, is the purpose——

General TRUDEAU. As against losing New York City and 10 million people.

Mr. DADDARIO. That, of course, is the purpose of my question.

General TRUDEAU. I am very glad to have this opportunity to clarify it, because I felt it might be misunderstood.

Mr. DADDARIO. I think it is extremely important. It is my understanding that that would be the circumstances under which the destruction would occur and that it would be destroyed without that kind of tremendous explosion over Hartford or any other city.

General TRUDEAU. That is correct, sir.

Mr. DADDARIO. This was the basis, and this is a further basis to support the Nike-Zeus program.

General TRUDEAU. It is in our opinion.

Mr. DADDARIO. And I share, too, with many of my colleagues on this committee your opinion and that which was propounded yesterday by General Lemnitzer that we do need this kind of an active defense. I further go along with the need of a stronger passive defensive system. That is all, Mr. Chairman.

The CHAIRMAN. Mr. Moeller?

Mr. MOELLER. General Trudeau, could you tell us the cost ratio between a Nike-Zeus and, let us say, a Polaris and a Titan.

General TRUDEAU. Now, we are getting into systems cost. I don't know, this would be difficult.

Mr. MOELLER. In generalities it would serve my purpose. Is it less costly, let's say, than a Polaris?

General TRUDEAU. One-fourth.

Mr. MOELLER. One-fourth the cost of a Polaris, and certainly much more less than the cost of a Titan?

General TRUDEAU. About one-quarter the cost of a Titan, I am told. The missile cost is about a quarter of Titan.

Mr. BASS. Would you yield?

Mr. MOELLER. All right.

Mr. BASS. You have just said that the Nike-Zeus program will cost about $9 billion and that is one-quarter of what the Titan costs, so it would be $36 billion——

Mr. MOELLER. I am talking about one missile.

General TRUDEAU. The physical cost of a Zeus missile is not over one-quarter of the cost of a Titan missile. But you have systems and a lot of angles here that make it very difficult to even discuss the problem.

Mr. MOELLER. If we had many Nike-Zeus, this would, of course, be defensive, but it could also be looked upon as offensive?

General TRUDEAU. Very definitely, very definitely.

Mr. MOELLER. In other words, we could actually get more for our money if it were spent on the Nike-Zeus program than possible either on Polaris or Titan?

General TRUDEAU. Well, I won't say that in that way. But I will say, I think I would be saying what General Lemnitzer said in effect, that we need some mix between the offensive and defensive. Naturally, as military people we believe in the offensive, we don't think you can sit on your duff and win anything. But on the other hand, we think a proper mix of our offensive capability with some defensive capability is necessary. If we are going to maintain our capability, the most important thing is to maintain our determination as a people so we can meet this challenge. You can't do it completely naked and exposed over a long period of time.

Mr. MOELLER. That is all.

The CHAIRMAN. Mr. King.

Mr. KING. General, I just wanted to express curiosity as to what those two exhibits were there in front of you, if they have some bearing on your discussion of this morning.

General TRUDEAU. Not particularly. This is our new solar furnace. In the interest of science and space I didn't know how broad the questions would be you asked here. I brought this example of the first piece of metal that was melted at some three or four thousand degrees temperature at our first solar furnace, which proves, even with due respect to you, Mr. Chairman, that your colleague, Mr. McCormack has some sunshine up in Massachusetts because this is located there.

The CHAIRMAN. Can you give use a demonstration of it now? Our weather today calls for some sunshine. [Laughter.]

General TRUDEAU. This is the pattern of MOBIDIC. This is an all-electronic data computer equipment, it is mobile and is being used in the field Army for the integration of information in a rapid manner, as is necessary today to meet this challenge. They were merely two other samples that I brought down along with these which I knew would interest you very much here. These are the items we are talking about.

Mr. KING. Thank you. When in response to Congressman Moeller's question you agreed that the Nike-Zeus had offensive as well as defensive aspects, you didn't mean to suggest by that that the Russians could interpret the Nike-Zeus system as being an offensive weapon, did you? It has no capacity to actually be launched against a ground target.

General TRUDEAU. No, the impact of Nike-Zeus is that it would vastly increase the Russian requirements as to the number of missiles they need to have available at any time that they thought they dared to launch the attack against us. This is another aspect of the psychopolitical problem.

Mr. MOELLER. Will you yield?

Mr. KING. Yes.

Mr. MOELLER. Of course, we could at the same time reduce our number of offensive missiles.

General TRUDEAU. This is a major question. There is a balance in there. This is for the Joint Chiefs of Staff. I wouldn't touch that one.

The CHAIRMAN. Mr. Roush?

Mr. ROUSH. Mr. Chairman.

General Trudeau, apparently there are people who feel there are very definite limitations on the use of Nike-Zeus?

General TRUDEAU. That is correct.

Mr. ROUSH. Limitations on their capabilities. In the statement you refer to the fact that you are constantly looking forward to discovering these capabilities. How long will it be before the research and development of the system is far enough along for you to determine these capabilities?

General TRUDEAU. We think that the critical time is going to be when we physically knock down an incoming ICBM and IRBM with them, which we are hopeful in doing in something over a year from now.

Mr. ROUSH. You are confident of certain of its capabilities now; is that correct?

General TRUDEAU. We feel confident, based on the best scientific appraisals that can be made of its abilities to do its job. But as I state very clearly the full missile, the complete system has not been tested and it will take time to do that.

Mr. ROUSH. Now, I want to try to clarify a question raised by my colleague, Mr. Fulton, and I believe Mr. Anfuso also followed up on this, but it isn't a matter of stopping research and development once we get into the production phase; that is correct, is it not?

General TRUDEAU. Of course, by the time you get into production phase, the major portion of your research and development should have been completed.

Mr. ROUSH. But you are constantly seeking new improvements and new capabilities of the weapon, are you not?

General TRUDEAU. We have greatly expanded the capabilities of the weapon in several fields over and above where we thought we were even 12 months ago, when we presented this problem to the committee.

Mr. ROUSH. Would you feel with this system as capable of improvement or modification after it is placed in production?

General TRUDEAU. We feel all systems are capable of improvement and we feel this can lead on to the next generation that will give us an antisatellite missile. We feel that with certain modifications it can give us a limited antisatellite capability, in itself.

Mr. ROUSH. The critical phase of present production that you refer to, when you refer to this $137 million, is a present construction phase: that is important, is it not, in considering its relationship to research and development?

General TRUDEAU. The question is "Yes" and "No." It becomes important in the consideration of the date that you want to have these missiles defending your cities. This is where it becomes important. It is an attempt to take production or present production and research and development up to this point where we finally test it and then start on the other. It is an attempt to telescope and gain 6 to 9 months or up to a year's time by getting into some of this additional work.

Mr. ROUSH. Is the date classified as to when this missile would be capable of defending our cities if we go into immediate production?

General TRUDEAU. This still has to go on the end of research and development. Is that still a classified date?

General DICK. Yes.

General TRUDEAU. It is well this side of 1965, I think we can say that. In fact, I said it, didn't I?

General DICK. You said it.

General TRUDEAU. OK.

Mr. ROUSH. I didn't hear that.

General TRUDEAU. I say this side of 1965.

Mr. ROUSH. When was Nike-Zeus assigned a priority?

General DICK. January 22, 1958.

Mr. ROUSH. And prior to that had a priority been requested and denied?

General DICK. I frankly don't know. I can find out for you.

Mr. ROUSH. Would you please?

(The information requested is as follows:)

The assignment of the priority on January 22, 1958, resulted from the Army's first request for assignment of priority dated September 5, 1957.

Mr. ROUSH. Now, this year, referring to the fiscal year 1961, have you been assured of all of the funds you requested for research and development of Nike-Zeus?

General DICK. Are you asking me?

Mr. ROUSH. General Trudeau, or whichever one can best answer it.

General DICK. Prior to 1961, the program has been essentially fully funded.

Mr. ROUSH. All right, the question I asked was with reference to 1961.

General DICK. The budget as it presently stands today provides full funds to test the system.

Mr. ROUSH. Was it the same amount of funds you requested?

General DICK. It was less than the funds we requested.

Mr. ROUSH. How much did you request?

General DICK. $323 million were requested. The budget carries $287 million. The difference lies in those moneys which would be requested to carry along training devices and documentation, maintenance provisions, and so on, which would accompany a decision to produce Zeus and put it in the field. If you are not going to put it in the field, you are not going to turn it over to troops, then you didn't need those extra moneys. So I say the $287 million is fully funding the system to demonstrate a capability.

Mr. ROUSH. Is this difference important to the Nike-Zeus?

General DICK. The difference is not an adverse factor at this time since there is no decision to produce.

Mr. ROUSH. Will the difference delay Nike-Zeus?

General DICK. No, not in research and development.

Mr. ROUSH. Thank you. I have just one other question: Is there any present military need for a superbooster engine?

General TRUDEAU. Such as Saturn?

Mr. ROUSH. Yes, sir, such as Saturn.

General TRUDEAU. Absolutely. Absolutely.

Mr. ROUSH. You disagree with the other services then in making that statement?

General TRUDEAU. No, it stands on its own feet. The communications satellite is going to be fired with a Saturn booster and we have stated the communications satellite is necessary in space.

Mr. ROUSH. Then there is a present need for a superbooster?

General TRUDEAU. I don't see how it can be denied. Do you know of anything else that can fire the communications satellite?

The CHAIRMAN. The gentleman's time has expired.

Mr. ANFUSO. May I just comment that General Trudeau—General Trudeau, has anybody ever told you that you talk like a former president, Harry Truman. [Laughter.]

General TRUDEAU. No, they haven't.

Mr. MOELLER. May we ask, Is he a candidate? [Laughter.]

The CHAIRMAN. Mr. Mitchell?

Mr. MITCHELL. General, let me commend you for not only talking like Harry Truman [laughter] but let me commend both you, General Trudeau, and General Dick for your sincere concern about the defense of the United States and I know it is not necessary but I urge you to continue to fight for the eventual production, early production of the Nike-Zeus system. And I think that with your efforts, that eventually it will have the effect of changing the prevailing philosophy of being penny wise and pound foolish insofar as the defense of America is concerned.

General TRUDEAU. Granting that there may be, and probably are, real and honest differences of opinion, we feel that we would be failing in our job if we didn't state our own conclusions based on the best information we are able to accumulate.

The CHAIRMAN. General, may I ask you this: You have nothing special to give us in executive session, do you?

General TRUDEAU. No, sir.

The CHAIRMAN. We have just a few moments before we go into executive session. I would like to ask General Trudeau one or two questions. On page 2 of your statement you refer to a billion dollars' worth of equipment, space equipment. Where do you have that equipment located?

General TRUDEAU. No, this is the total research and development facilities available to the Army.

The CHAIRMAN. Where are they located?

General TRUDEAU. They are scattered throughout the United States.

The CHAIRMAN. Could you give us a list, if it isn't too much trouble, that we could insert in the record so we will know pretty well where your research and development——

General TRUDEAU. Major research and development installations by technical service. I will be glad to do that.

(The information requested is as follows:)

U.S. ARMY INSTALLATIONS HOUSING RESEARCH AND DEVELOPMENT ACTIVITIES

PART I. ARMYWIDE AND U.S. CONTINENTAL ARMY COMMAND INSTALLATIONS

Fort Benning, Ga.: This installation includes both the Infantry Human Research Unit and the Infantry Board. The Human Research Unit conducts research to develop new techniques of infantry training. The Infantry Board conducts service tests of infantry weapons, ammunition and fire control items, clothing, equipment, and protective devices for the individual, small detachment and individual rations, and field messing equipment.

Fort Bliss, Tex.: The Air Defense Human Research Unit, located at Fort Bliss, conducts research to develop new techniques of electronics training and training of personnel to operate air defense units. The Air Defense Board conducts service tests on antiaircraft and selected field artillery guided missile systems, antiaircraft artillery weapons and fire control equipment, target drones,

and antiaircraft fire direction systems. The Office of Special Weapons Developments at this installation advises and assists the deputy commanding general of the U.S. Continental Army Command with development of requirements for doctrine, equipment, organization, and training as they pertain to the employment of atomic energy by the Army in the field.

Fort Bragg, N.C.: The Airborne and Electronics Board, at Fort Bragg, conducts service tests on communications and electronics equipment which are not a part of weapons systems, tests on infrared devices, and on special airborne and special air support equipment.

Fort Churchill, Manitoba, Canada: Fort Churchill is a Canadian-operated installation wherein the U.S. Army shares facilities with the Canadian Army. This installation provides facilities for engineering testing of development items in the arctic environment. The U.S. Army also operates a rocket research facility for various United States and Canadian agencies.

Fort Greeley, Alaska: The Army Arctic Test Board, at Fort Greeley supports all other U.S. Army boards by conducting arctic and subarctic portions of service tests.

Fort Gulick, Panama Canal Zone: This installation provides a high humidity, high temperature jungle environment for engineer testing of certain Corps of Engineers equipment.

Fort Knox, Ky.: Located at Fort Knox is the Armor Human Research Unit, the Armor Board, and the Army Medical Research Laboratory. The Research Unit conducts studies in armor training problems and the Armor Board conducts service tests on armored vehicles and associated weapons, ammuntion and fire control equipment, selected engineer materiel, and radiation detection instruments. The Medical Research Laboratory, working under the Surgeon General, conducts basic and applied research on physiological, biochemical, biophysical, psychological, and psychophysiological problems that have military significance.

Ford Ord, Calif.: The Combat Development Experimental Center at Fort Ord conducts scientific controlled experiments of new concepts, organizations, doctrines, and procedures for future combat.

Fort Rucker, Ala.: The Aviation Human Research Unit and the Aviation Board are both located at Fort Rucker. The Human Research Unit conducts training and research in support of Army aviation, and the Aviation Board conducts service tests of a wide variety on aviation equipment. This equipment includes Army aircraft, communication and navigational aids used in controlling aerial flight, individual protective equipment, flight clothing, parachutes and personal equipment for aviators and crew members, portable hangars or other airfield facilities, airborne camera systems, airborne detectors (including radar, infrared, magnetic, and radiological), optical viewing devices for air observers, and maintenance equipment. This Board also maintains a constant review of aeronautical equipment developed by other services and civilian companies for application to Army aviation requirements.

Fort Sill, Okla.: The Artillery Board located at this installation conducts service tests on field artillery weapons, ammunition, radars, survey, sound and flash ranging equipment, meteorological equipment, and searchlights.

Presidio of Monterey, Calif.: Leadership training and mobilization research is conducted at this installation by the Leadership Human Research Unit. The work of this Unit includes studies to determine factors related to effective combat performance, techniques for training junior officers, leadership training for noncommissioned officers, and means for increasing the motivation of soldiers.

Yuma Test Station, Yuma, Ariz.: The desert climate in the Yuma Test Station permits hot weather and desert environmental testing of development items, both for engineer and service test.

U.S. Army Research and Development Group, Frankfurt, Germany: This agency was established in 1956 to establish and maintain contact with the European Scientific Community and to receive research proposals and to negotiate and administer research and development contracts in Europe.

U.S. Army Far East Research Office, Tokyo, Japan: This agency enables the U.S. Army to exploit the many research capabilities existing in the SEATO nations and to serve as a focal point for contacts between U.S. Army scientists and the scientists of the SEATO nations.

PART II. U.S. ARMY ORDNANCE CORPS INSTALLATIONS

Aberdeen Proving Ground, Aberdeen, Md.: All classes and types of Ordnance materiel, except the guided missile systems, the large caliber rocket systems, and aerial target drones are tested and evaluated at this installation. In addi-

tion, ballistic research and Ordnance weapons system evaluation are also carried out. Finally, those special missions relating to human engineering studies, explosive Ordnance disposal activities, coating, and chemical research are carried out here.

Diamond Ordnance Fuze Laboratories (DOFL), Washington, D.C.: This installation conducts both research and development in the various physical sciences and engineering fields for fuzes and related items.

Office of Ordnance Research, Durham, N.C.: This office is charged with planning, directing, and appraising the conduct of basic research of current and future Ordnance interests. This includes the collection, evaluation, and dissemination of information achieved from research conducted by the Ordnance Corps, by other Department of Defense agencies, and by other governmental, private, and foreign agencies.

U.S. Army Ordnance Missile Command, Huntsville, Ala.: In addition to the responsibility for weapon system management for all missile systems, this installation conducts basic research projects in the fields of missile and rocket development. It executes supporting research projects and conducts developments on ballistic and guided missile weapons systems and on space missiles or vehicles, and it executes space missile or vehicle development.

Rock Island Arsenal, Rock Island, Ill.: The Ordnance Weapons Command, located at the Rock Island Arsenal, controls the Springfield Armory, Springfield, Mass., and the Watertown Arsenal, Watertown, N.Y., in addition to the Rock Island Arsenal, Ill. In addition to the procurement and production functions of these several arsenals, basic research in the fields of metals and other materials as well as development of many Ordnance items is conducted.

Picatinny Arsenal, Dover, N.J.: This installation conducts both basic and supporting research in the fields of plastics, adhesives, and nonmetallic materials, as well as certain development and testing responsibilities with respect to explosives, and certain end items of ammunition.

Ordnance Tank Automotive Command, and its subordinate agency Detroit Arsenal, Detroit, Mich.: Conduct necessary research and development in all tank and automotive vehicles and power systems for vehicles.

Frankford Arsenal, Philadelphia, Pa.: At this installation, development of certain fire control systems and fire control components is conducted.

Watervliet Arsenal, N.Y.: This installation is charged with development of that category of Ordnance materiel classified as cannon.

White Sands Missile Range, White Sands, N. Mex.: This installation provides facilities for the engineering and service testing of the Army's missile systems, and operates range facilities for the other services.

PART III. ARMY SIGNAL CORPS INSTALLATIONS

Signal Research and Development Laboratory, Fort Monmouth, N.J.: This installation conducts continuing research in all fields of physical science leading to the development of new techniques and the design and improvement of communications, radar, electronic countermeasures, electronic data processing, radiological, meteorological, photography, drones, and other surveillance equipment and related components.

U.S. Army Electronic Proving Ground, Fort Huachuca, Ariz.: This installation provides facilities for engineering and service tests of communications and electronic equipment.

U.S. Army Combat Surveillance Agency, Arlington, Va.: The Combat Surveillance Agency coordinates all phases of the surveillance activities conducted by the Chief Signal Officer as well as that work done by other technical services of the Department of the Army and of the Navy and Air Force.

The Signal Air Defense Engineering Agency, Fort George G. Meade, Md.: This agency provides research, analysis, development, engineering, installation and test of the Army's Air Defense Environmental Systems, as well as their integral and associated telecommunications and electronics.

Signal Electronic Research Unit, Mountain View, Calif.: This agency serves as a technical representative for the Signal Corps contracts with Sylvania Electric Products, Inc., for operation and maintenance of the development facility known as Electronic Defense Laboratory.

PART IV. U.S. ARMY CHEMICAL CORPS INSTALLATIONS

Army Chemical Center, Md.: The Army Chemical Warfare Laboratories, located near Edgewood, Md., conduct research and development work in the fields

of offensive and defensive toxic chemicals, radiological, smoke and flame warfare, to include lethal and incapacitating agents, munitions, weapons, defensive measures, design and operation of pilot plants, and evaluation of developmental agents and munitions systems.

Fort Detrick, Frederick, Md.: The U.S. Army Biological Warfare Laboratories, located at Fort Detrick, conduct research in the fields of lethal and incapacitating antipersonnel BW agents, research on detection and warning devices for BW attack, as well as many classified projects. In addition, the U.S. Army Medical Unit of the Surgeon General located at this installation determines the risks to the U.S. Armed Forces of biological warfare attacks, and where indicated, develops appropriate biological protective measures.

Dugway Proving Ground, Utah: This installation provides facilities for testing the chemical, biological, and radiological warfare developments from the Army Chemical Center and from Fort Detrick. Because of the extent and location of this facility, large-scale development testing as well as the testing of highly lethal and infective CW, BW, and RW agents are conducted.

PART V. U.S. ARMY CORPS OF ENGINEER INSTALLATIONS

Fort Belvoir, Va.: The Engineer Research and Development Laboratories, located at Fort Belvoir, constitute the principal field agency of the Corps of Engineers for the accomplishment of research and development of Engineer materiel, methods, and techniques required for military operations. Included in the research and development work, conducted at this installation, are such widely varied projects as gasoline, diesel, and steam engines, mobile industrial gas generating, storing and distributing equipment, construction equipment, bridges, equipment for handling POL, map reproduction and terrain modelmaking equipment, infrared and night vision devices, concealment, and camouflage techniques, etc.

Snow, Ice and Permafrost Research Establishment, Evanston, Ill.: This activity conducts research and development in the field of snow, ice, and frozen ground, on and beneath the Earth's surface.

U.S. Army Waterways Experiment Station, Vicksburg, Miss.: This installation undertakes, on a reimbursable basis, experimental studies pertaining to problems in the general field of hydraulics, soils mechanics, flexible pavement, and concrete.

Camp Tutto, Thule, Greenland: The U.S. Army Polar Research and Development Center, at Fort Belvoir, conducts in the Camp Tutto area research in problems associated with the polar environment.

Houghton, Mich: Both the Corps of Engineers and the Transportation Corps perform deep snow research and equipment testing in snow conditions at this installation.

PART VI. U.S. ARMY TRANSPORTATION CORPS INSTALLATIONS

Fort Eustis, Va.: The U.S. Army Transportation Research and Engineering Command, located at Fort Eustis, supervises development programs of Army aircraft, provides work on amphibious vehicles, harbor craft, and associated marine equipment, works on specialized off-road vehicles such as trackless trains and rolling fluid transporters, develops terminal handling equipment such as aerial tramways, and develops specialized military railroad equipment.

Transportation Corps Aviation Field Office, Dayton, Ohio: This field office provides coordination for the Department of the Army with the designated agencies of the Departments of Air Force and Navy in all fields of aviation research.

PART VII. U.S. ARMY QUARTERMASTER CORPS INSTALLATIONS

Natick, Mass.: The Quartermaster Research and Engineering Command, located at Natick, conducts research and development in such Quartermaster items as food, clothing, shelter, petroleum distribution, materials handling, tentage, laundry, shower, heating, and cooking equipment.

Quartermaster Maynard Test Site Maynard, Mass.: Plans and conducts field evaluation for the QM R. & E. Command at Natick.

Quartermaster Food and Container Institute for the Armed Forces, Chicago, Ill.: Under the direction of the Research and Engineering Command, Natick, Mass., this agency designs, develops, evaluates, and improves food and ration

components of all types for the armed services, as well as containers for food and other items.

Fort Lee, Va.: The Quartermaster Research and Engineering Field Evaluation Agency plans and conducts field evaluation tests, studies, observations, and supporting research for the Research and Engineering Command at Natick, Mass.

Quartermaster Radiation Planning Agency, Washington, D.C.: This agency develops all plans necessary for the establishment and operation of the U.S. Army Ionizing Radiation center.

PART VIII. U.S. ARMY MEDICAL SERVICE INSTALLATIONS

Walter Reed Army Institute of Research, Washington, D.C.: This installation plans and conducts research and development in the fields of medicine, dentistry, veterinary medicine, and the allied medical sciences.

Fort Sam Houston, Tex.: A U.S. Army surgical research unit, located at Fort Sam Houston, investigates problems arising in all fields of military surgery, to include problems of mechanical and thermal injury and complications arising from such trauma.

U.S. Army Prosthetics Research Laboratory, Washington, D.C.: This agency conducts fundamental research, applied research, testing, development, and training in the techniques of fitting new devices in the field of prosthetic and orthopedic appliances.

U.S. Army Medical Research and Nutrition Laboratory, Denver, Colo.: This agency determines the nutrient intake of the soldier under various conditions in order to evaluate the adequacy of his diet. In addition, it assesses the health, nutrition, and performance capacity of troops in all environments in order to ascertain whether they are well fed and are as healthy and as fit as is compatible with local danger, disease, and environment.

Fort Totten, N.Y.: The U.S. Army Medical Equipment and Development Laboratory at Fort Totten designs and develops new items of military medical equipment for all three services.

U.S. Army Medical Research Unit, Kuala Lumpur, Malaya: This unit investigates fevers of undetermined origin and other diseases of potential military importance in southeast Asia.

U.S. Army Tropical Research Medical Laboratory, San Juan, P.R.: This medical laboratory conducts tropical medical research which will ultimately prove beneficial to combat troops stationed in similar environmental areas.

U.S. Army Medical Research Unit, Landstuhl, Germany: This unit conducts studies regarding radioactivity in man.

U.S. Army Medical Research Unit, Panama: This unit conducts studies of diseases of military importance in middle America.

The CHAIRMAN. One more thing, through your statement as you went along, you added in some places after you had gotten the authority to go ahead and in other places you changed a word and inserted the word "authority." I think back to the hearings we had in the Armed Services Committee a number of years ago where it was shown that you could have gotten a Jupiter C in orbit before Sputnik No. 1 if you had been given authority. Does that have anything to do with your shifting of the words there in your statement today?

General TRUDEAU. Not particularly. I think this is true. I was not in this particular end of the game at the time, but there are several cases, such as Saturn that I mentioned this morning, where we feel that had authority been forthcoming sooner that the work could have been expedited.

The CHAIRMAN. You could have gotten Jupiter C in orbit before Sputnik, if you had been given the authority to do it?

General TRUDEAU. The answer is "Yes."

Mr. BASS. Mr. Chairman.

The CHAIRMAN. I yield.

Mr. BASS. I just want to clear up one matter, General.

With regard to those individuals who disagree with you on Nike-Zeus, you don't impugn their sincerity and loyalty, do you?

General TRUDEAU. I hope I have made that clear. No, I don't, and there are some very fine brains that don't agree with me or our people.

Mr. BASS. You don't agree with the statement that their decision has been motivated by budgetary reasons or anything like that, do you?

General TRUDEAU. From my viewpoint I wouldn't permit myself to think that.

Mr. BASS. Thank you.

The CHAIRMAN. Now, General, do you need any additional authority, in your opinion, to go ahead, outside, of course, of the release of that $137 million. Do you need any other additional authority to proceed with the space program in areas which you consider vital to the security of the United States?

General TRUDEAU. Well, I think these are forthcoming. We are looking for clarification at an early date on responsibility for the communication payloads, about which I have spoken briefly. We are making the studies on those, primarily under our Signal Corps now, but we do not have an assignment of the communication payloads officially and in full and complete with funds today.

The CHAIRMAN. And you need that assignment now, do you?

General TRUDEAU. Yes, sir.

The CHAIRMAN. And it would save time if you got the assignment?

General TRUDEAU. Absolutely.

The CHAIRMAN. How much time would you save?

General TRUDEAU. Well, every day saved is just that much time. This is about what it amounts to.

The CHAIRMAN. Mr. Hechler?

Mr. HECHLER. I would just like to concur with my colleagues, Mr. Mitchell and Mr. Anfuso, and say that I think that both you, General Trudeau, and General Dick have made magnificent statements this morning and I hope you will stick to your guns.

General TRUDEAU. Thank, you sir.

The CHAIRMAN. Mr. Moeller?

Mr. MOELLER. General Trudeau, if you would rather not answer this in open session, maybe you could tell us in executive session: Would you give us your honest opinion as to why you think the Von Braun team was transferred from the Army? We hear many reasons about this.

General TRUDEAU. Well, I don't know. It would only be surmise on my part. I think there have been certain jealousies that are bound to have been stimulated by the Army's success in this field. I think there are honest doubts in the minds of many people as to whether the Army should be in space. There are some people who do believe that one service or one agency should have control of everything that has to do with space. There are probably psychological reasons and again psychopolitical—since you like that word, I will use that—as to why we should accent the civilian aspects of this effort and play down the military implications, and those to my mind—and then there can be others which you can evaluate better than I can—that all add up to this problem and the current solution to it.

The CHAIRMAN. Thank you very much, General. Thank both of you, General Trudeau and General Dick, for very fine statements that you have made to us.

Now, tomorrow morning, I will say that we have General Medaris with us. We will probably get some fine statements there, too. [Laughter.]

General TRUDEAU. Since he is no longer on the active rolls of the Army, you should.

The CHAIRMAN. We look forward to hearing his testimony——

Mr. ANFUSO. You heard the comment of the general, General Medaris is no longer on the active roll of the Army.

The CHAIRMAN. These gentlemen — I will say this, whether they are on the active rolls or not, they speak their mind, they say their convictions and it is always pleasant to have witnesses before us who do give us their sincere convictions. Sometimes we don't agree with them, though.

General TRUDEAU. That is all right.

The CHAIRMAN. But we are happy to have you.

The committee will go into executive session.

(Whereupon, at 11:41 a.m., the committee proceeded into executive session.)

(The executive session is classified and will not appear here.)

REVIEW OF THE SPACE PROGRAM

THURSDAY, FEBRUARY 18, 1960

House of Representatives,
Committee on Science and Astronautics,
Washington, D.C.

The committee met at 10 a.m., Hon. Overton Brooks (chairman) presiding.

The Chairman. The committee will come to order.

This morning we have two distinguished witnesses. We have Maj. Gen. August Schomburg, who is with the Army Ordnance Missile Command at Redstone Arsenal in Alabama, and we have, then, Maj. Gen. J. B. Medaris, U.S. Army, retired, previously from the Redstone Arsenal.

Now, my thought is this: General Medaris is not called until 10:30. We will have a statement by General Schomburg and then as soon as General Medaris comes in, we will have his statement and then we will submit questions to both you, General Schomburg, and General Medaris at the same time and you can take your choice as to which one wants to answer which question. It will be all right with the committee.

You have a prepared statement, don't you?

General Schomburg. I do, sir.

The Chairman. Would you like to proceed with that, General Schomburg?

STATEMENT OF MAJ. GEN. AUGUST SCHOMBURG, COMMANDING GENERAL; ACCOMPANIED BY COL. CALVIN HEATH; AND COLONEL ZIERDT

General Schomburg. Yes, sir.

Mr. Chairman, members of the committee, I am Maj. Gen. August Schomburg. It is a pleasure to appear before you today, especially since this is my first appearance before Members of Congress as the commanding general, Army Ordnance Missile Command.

I should mention that although I have been commanding AOMC only since the 1st of February, I have been intimately connected with the Army's missile programs, including Nike-Zeus, for nearly 4 years.

The Chairman. You are located down at Redstone?

General Schomburg. I am now at Redstone.

The Chairman. You succeeded General Medaris?

General Schomburg. I have succeeded General Medaris.

Mr. Fulton. May we welcome the general into this new line of fire.

The Chairman. By the way, you will notice it is a crossfire, both sides. [Laughter.]

General SCHOMBURG. My connection with the Army missile programs began nearly 4 years ago, when I was Assistant Chief of Ordnance for Research and Development, and continued later when I became Deputy Chief of Ordnance, the job I held before going to the Redstone Arsenal.

I was also the Army's principal negotiator for the transfer of JPL to NASA, and about that same time for the use of the Army Ordnance Missile Command by NASA in space work; and then most recently again on the transfer that is about to take place.

I would like to introduce now two of the officers of my command who are here. I would like to introduce first, Col. Calvin Heath, who has been primarily responsible at AOMC for the command's work on the NASA transfer.

Colonel HEATH. Good morning.

The CHAIRMAN. Nice to have Colonel Heath here.

General SCHOMBERG. I would also like to introduce Colonel Zierdt, who is now known as Colonel Zeus.

The CHAIRMAN. General, before you get started and before the two colonels get started, under this posture hearing we have sworn all of the witnesses. I will ask all of you three gentlemen, if you will, to stand up. Do you and each of you solemnly swear that the testimony you will give before this committee in matters under consideration will be the truth, the whole truth, and nothing but the truth, so help you, God?

General SCHOMBURG. I do.

Colonel HEATH. I do.

Colonel ZIERDT. I do.

The CHAIRMAN. Thank you, sir.

General SCHOMBURG. Mr. Chairman, you have mentioned that you have a heavy schedule this morning. Recognizing this, I would really like to submit my statement for the record, rather than to take the time to read it.

The CHAIRMAN. All right.

General SCHOMBURG. I can brief it for you in a few minutes.

The CHAIRMAN. You stand on your statement.

General SCHOMBURG. I do.

The CHAIRMAN. We will put that in the record.

(The statement is as follows:)

Mr. Chairman, members of the committee, I am Maj. Gen. August Schomburg, commanding general, Army Ordnance Missile Command. It is a pleasure to appear before you today, especially since this is my first appearance before Members of the Congress as commanding general of the U.S. Army Ordnance Missile Command.

I am assured that the committee is familiar with the accomplishments and competence of this organization, so I shall not recount them here. However, I am compelled to say that even my brief residence at Redstone Arsenal has confirmed an old opinion that AOMC is indeed a national asset.

I count my new assignment a challenging one, even more so when I consider the future. We are faced with the transfer of the Von Braun group, an action which may restrict one area of our missile development capability. Yet our fundamental mission of providing weapons for defense remains unchanged, and, to be realistic, we must plan to meet future demands for more and more sophisticated weapons.

So we must now make certain changes in the application of our remaining resources, and we must supplement those resources where necessary and possible. It is a challenge of considerable magnitude, but it is a challenge which our experience equips us to meet with confidence.

The term "providing weapons for defense" is a handy generality, a sort of "shorthand" for expressing the job that has been assigned to AOMC. The substance and content of that assignment change constantly, because technology itself is ever-changing. As in Alice in Wonderland, we must run very fast in order to be able just to stay in the same place. But we do more than that, for it is our job to forge ahead: and we have gathered together at AOMC a great many of the Army's most capable and forward-looking people and have given them an environment in which to function effectively in the execution of our mission.

The AOMC organization has several unique features. Our headquarters staff includes representation from the combat arms. Through the Office of Military Applications and Training, the requirements of the user are integrated into everything we do, day by day.

A missile system is a composite development of many technologies. So representatives from the Army Corps of Engineers, the Signal Corps, the Transportation Corps, and the Quartermaster Corps serve on the AOMC staff. These people perform a development function in tying the other Army technical services into ordnance weapon systems development.

For example, although the AOMC agency contracts for the communications equipment which is integral to a missile weapon system, the Signal Corps exercises technical supervision over the execution of that portion of the missile system contract. We depend on the Signal Corps for basic advances in electronic components. We depend on the Corps of Engineers for the development of all generators, air compressors, air-conditioning equipment, and other power equipment, and for the construction of facilities. The Army Engineers are now engaged in construction of Zeus facilities at White Sands Missile Range, Johnston Island, Kwajalein, Point Mugu, and Ascension Island. We depend on the Transportation Corps for all aspects of transportability during development and test, and in the final, fielded weapon system. We depend on the Quartermaster Corps in developing materials handling equipment, various field shelters, heating equipment, and special clothing. We are also supported by a host of ordnance districts and agencies, including Frankford, Watertown, and Watervliet Arsenals, the Diamond Ordnance Fuze Laboratory, the Ordnance Weapons Command, and Aberdeen Proving Ground. Picatinny Arsenal provides us with warhead adaption kits; the Ordnance Tank and Automotive Command with trucks and vehicles.

In turn we support others. We are developing components for the Shillelagh antitank weapon system, which is under the weapons system management of the Ordnance Tank and Automotive Command. Our missiles could be used as carriers by the Chemical Corps. And so on.

Among the "weapons for defense" we are now providing are the Corporal and Redstone systems, both of which have been deployed overseas. We are providing and supporting these two operational ballistic missile systems.

Further, the Jupiter intermediate range ballistic missile system has been ready for deployment overseas since December 1958, and we are now assisting the Air Force in the deployment of Jupiter to Italy.

We have two solid propellent ballistic missiles under development: The Sergeant system, with a nuclear warhead capability and a range of 75 miles, which will eventually succeed the Corporal; and the Pershing, a longer range ballistic missile, which will in the future succeed the liquid propellent Redstone.

Our surface-to-surface rocket systems include Honest John, deployed in 1953; and Little John, which will provide our airborne forces with a "Sunday punch." Development work is being conducted to increase the performance capability of both of these systems.

Our mobile air defense weapons include Hawk, which will complement our defense against high-level air attack by meeting the low-altitude threat. Hawk will be deployed this year. Hawk has also been selected by our NATO allies for production and deployment overseas.

Mauler is to be a highly mobile weapon for air defense in forward areas. Mauler's feasibility study has been completed and development will be initiated in the near future.

Redeye is an individual weapon for the man in combat. It is a shoulder-fired antiaircraft missile which homes on its target. Redeye resembles the bazooka in size and appearance although it is much lighter in weight, and gives frontline and support troops a low-altitude antiaircraft defense. The Redeye is in the early development stage.

We are also developing LAW, a light antitank weapon. It will enable an individual soldier to defeat the majority of tanks he will encounter, close up, in battle.

Lacrosse is an extremely accurate surface-to-surface guided missile which destroys hard targets such as pillboxes. Lacross artillery units are now in training for deployment.

The Nike progression of missiles provides a striking example of continuing growth in the Army's missile technology.

At the outset of the Nike-Ajax project in 1945, an Army evaluation of the threat expected 10 years in the future suggested the subsonic, high-altitude piloted bomber as the central element of the 1955 offensive threat. The Nike-Ajax program provided the free world with an effective antiaircraft guided missile system. Ajax has been deployed since 1953 for the protection of cities and industrial centers throughout the continental United States. Ajax has repeatedly demonstrated its capability to destroy the fastest jet aircraft.

The Nike-Hercules program began in mid-1953. The Hercules system, with its solid propellent rocket motors, was calculated to meet the threat of supersonic aircraft and air-breathing missiles. To meet that threat, we now have the Hercules surface-to-air guided missile, with either conventional or atomic warhead, which is capable of destroying single or multiple targets. The Hercules system, now deployed, has destroyed the highest performance targets; and, indeed, no targets have yet been made available which are able to exercise the system to its limit.

While providing timely national air defense, Ajax and Hercules laid groundwork of priceless experience for the era of the ballistic missile and satellite threat. In November 1956 the Army staff approved a program for the development of the system which is now known as Nike-Zeus. Knowing the threat that faces the free world, we have pursued the development of Zeus with consecration. Our knowledge of U.S. defensive missile technology convinces us that Zeus will provide a workable solution to IRBM and ICBM defense; our knowledge of Soviet offensive capabilties convinces us that Zeus development must be pursued as expeditiously as our resources will allow.

In addition to the current weapons programs, a comprehensive consideration of AOMC activities must give due weight to our need for planning beyond the more immediate defense preparations. Unless we anticipate tomorrow's requirements and orient our research accordingly, we shall be unable to fulfill those requirements when they are expressed.

We must further explore the advantage of missiles in new techniques of warfare. For example, the speed and assurance with which high priority cargo could be delivered by missiles to isolated combat units make such a concept attractive. The economic ramifications of this concept are especially compelling when one considers the attrition rate of aircraft in supplying isolated units in combat, an attrition rate which will be prohibitive in future warfare.

An extension of this concept is missile delivery of small Army teams over great distances with pinpoint accuracy.

Because the feasibility of these and many other concepts is dependent upon the support of continuing research, we incessantly seek authority for expansion of our supporting research activities. There has been a frantic using up of our knowledge in the crash development of missiles in the past 10 years. During the same 10 years the competition for funds for missile development has crowded supporting research out of our budgets. So we have virtually exhausted our reservoir of knowledge. We must replenish it or yield our ascendancy—and eventually yield even our equality in the missile race.

This, gentlemen, has been an introductory account of what we have done—what we are doing—and what we hope to be allowed to continue to do.

Finally, whatever the substance and content of our present and future missions, it is our hope and expectation that the vitality of the Army missile organization will be sustained and increased by the support which those who direct our Government can give it.

Gentlemen, it is a pleasure to appear before your committee. I assure you that my command is ready at any time to assist you in your vital work. I shall be happy to attempt to answer any questions you may have.

General SCHOMBURG. My opening statement tells of the setback that we will suffer as a result of the transfer of the Von Braun team to NASA, but at the same time, it assures you of our determination to

reestablish the competence necessary to continue the fine job that the Army Ordnance Missile Command is doing and has done.

I should mention that the transfer will in no way affect the Zeus program. This program is handled by an entirely different part of my organization. It is not handled by the Von Braun team.

The formal statement describes our presently deployed missiles and the missile systems that are coming on in the future, and it tells you of the confidence that we have in the Zeus system. It tells you of our forward-looking attitude. In short, it tells you, sir, of our enthusiasm for the Army's missile job.

If you would like, I am open for questions, sir.

The CHAIRMAN. That is your complete statement, in brief?

General SCHOMBURG. This, I think, briefs it very well, sir.

The CHAIRMAN. We are glad to have you here for your first appearance before a committee of Congress, General. You have a most important assignment, and in your present assignment, you have control, do you not, of the backup for the Von Braun team down there?

General SCHOMBURG. I certainly do: and this is quite a responsibility, sir. It is my responsibility to see that that team is transferred without loss of momentum. This, as you know, starts on the 1st of July, and, as far as we are concerned, it is now planned that it will be about completed by a year from now.

The CHAIRMAN. My thought is this: General Medaris will be here at 10:30. I suggest that each member take one question. We will go around and then General Medaris will be here by that time; we will have his general statement. Then everybody can question both of the witnesses at the same time.

So I will ask one question now. Are you satisfied that the transfer can be made now without too much loss of momentum, and are you satisfied that you are going to get cooperation from NASA in your position?

General SCHOMBURG. The answer to that is "Yes." I might enlarge on it a little bit, sir. I feel that we can do this. As you know, we really have complete management responsibility for Dr. Glennan until the 1st of July; we carry on for him until that time. In the meantime, he will be building his administrative and support organization. NASA will start to take over on the 1st of July and then completely take over by the first of the year. I think this should work.

There is one problem, I think, that might be mentioned. The Von Braun team, of course, is unique, a great national asset, no doubt about it. It has done an absolutely marvelous job. However, this job, I think, might not have been possible without the management and the logistics support which the Army has given to Dr. von Braun and the Development Operations Division.

Now, we are furnishing cadres to NASA to help them in building their own support of the team, but this is not the same as transferring the management and the logistic support. That will stay with us. So I think there is quite a problem here to support the Von Braun group in the manner to which it has become accustomed.

The CHAIRMAN. Mr. Fulton.

Mr. FULTON. Glad to have you here. Yesterday evening General Schriever, on behalf of all the services, said before the National Rocket Club, and very firmly, there is no missile mess, and that

because of the progress that has been made in all the services through the scientists on the U.S. missile and space program, that it is a missile miracle.

Do you agree with him or disagree?

General SCHOMBURG. I think that is rather a good statement, sir.

Mr. FULTON. Thank you.

General SCHOMBURG. Yes; I think so.

The CHAIRMAN. Mr. Teague.

Mr. TEAGUE. Since you are in a new line of fire, let's start a little bit of fire. Do you agree with General Medaris that we should not have created NASA and that the whole space program should be under the military?

General SCHOMBURG. You know, I would rather you would ask General Medaris that, sir.

Mr. TEAGUE. General Medaris has already answered. I am asking you.

General SCHOMBURG. Well, I will answer this way: My job has been intimately connected with the Army's weapons up until now, as distinguished from scientific space exploration. I have just landed in a new job. I am anxious to be responsive in that job. I don't think that I have thoroughly thought out the question of the whole big problem, so I am really not prepared to give you an answer, sir.

Mr. TEAGUE. I will ask you the same question the next time you come up here.

General SCHOMBURG. Yes, sir. [Laughter.]

Mr. VAN PELT. No questions, Mr. Chairman.

The CHAIRMAN. Mr. Sisk?

Mr. SISK. Mr. Chairman. General, I would just like to ask your comment on the paragraph at the bottom of page 6 in your statement where it starts off—

> Because of the feasibility of these and many other concepts—

and goes on to say—

> There has been a frantic using up of our knowledge in the crash development of missiles in the past 10 years. During the same 10 years the competition for funds for missile development has crowded supporting research out of our budgets, so we have virtually exhausted our reservoir of knowledge. We must replenish it or yield our ascendency and eventually yield even our equality in the missile race.

Would you comment briefly on that paragraph, just what you—particularly with the point on this fact that we have virtually used up our knowledge?

General SCHOMBURG. For a number of years my experience has been largely in the research and development field. I think you will find most of us in this area believe that supporting research is really the heart and soul of our future. We have had a fairly good program, but it is dropping off. We do not put as much money into it now as we did previously.

The demand, on the other hand, is becoming greater all the time. As the systems become more complicated, more technical, we are trying to do more difficult things. So I am quite concerned that we are not putting more money into this supporting research, into component development, to develop the pieces that it takes to put together to make a system. We are not doing as much of that as we should.

Mr. SISK. I think it is a good statement. I am inclined to agree with it, but I think it is rather significant and I am very glad that you made it, that is why I wanted you to expound on it.

Mr. BASS. No questions.

The CHAIRMAN. Mr. Wolf?

Mr. WOLF. General, how do you see your job, what is your job? I am not sure I got that from the discussion this morning.

General SCHOMBURG. Yes, sir; let me tell you what my job is. It breaks down now into perhaps three separate pieces.

One part of my job is to see that the Von Braun team, this great national asset, is transferred to NASA without loss of momentum. This is one job I have.

Another job I have is to see that our Army missile programs go forward; that they do not lose momentum; that we continue to do a forward-looking job; and that we continue to give the Army what it needs. This is a very important part of my job.

Certainly another important part of my job is to reestablish in the Army Ordnance Missile Command that competence we need which goes out with the Von Braun group. We are giving the Von Braun group to NASA, along with $100 million in facilities and equipment. We certainly do not expect to be able to rebuild that, not even a major portion of it. But some of this is going to have to be reestablished so that we can do our job.

The agreement, on the other hand, provides that there will not be duplication at Redstone Arsenal. If there is a test stand that can serve both of us, we will both use it.

The people—and this is very important. We are going to have to get some people—not nearly as many as the 4,700 we will lose, but we are going to have to get some people to fill in the gap that they will leave, and this is another part of my job.

So my job, you might say, in this last field, is to put us back on a going basis. And this, of course, we certainly intend to do.

The CHAIRMAN. Mr. Riehlman?

Mr. RIEHLMAN. General, in your briefing you referred to the tremendous loss to the Army in the transfer of the Von Braun team. Could you very briefly tell us just how that is going to directly affect the Army's own missile program?

General SCHOMBURG. Yes, sir. Now, we have—I can talk about the present and the future.

Mr. RIEHLMAN. That is right.

General SCHOMBURG. For our present programs we have made mutual arrangements for the Pershing, which is one of the most important; the Redstone, which still needs support; and the Jupiter, which still needs support. We have a completely satisfactory arrangement for the assistance of the team to finish those jobs. So I am not worried about those.

For future work, however, when we are coming up with a new weapon system where we would need that team, they would be able to help us only on an as-available basis. This means possibly on very low priority, after all the space work is done. I am not at all sure that in the future the Von Braun group would be able to serve us.

On the other hand, I certainly expect that we will build up the competence in our own organization to carry on the Army programs when the team is not available to us.

Mr. RIEHLMAN. Thank you.

The CHAIRMAN. Mr. Karth?

Mr. KARTH. No questions.

The CHAIRMAN. Mr. Hechler?

Mr. HECHLER. General Schomburg, I was very interested in the fact that in your oral statement you used the words "a setback" in terms of the transfer of the Von Braun group.

Now, I initially supported this transfer because I was so deeply concerned with the future success of Saturn that I wanted to see that Saturn was well funded and I believed that possibly that might be the only way to do it. But I want to be the first to admit publicly that I was wrong, that I was wrong in supporting this transfer because I didn't have available the facts that you are giving this committee and the facts that others are giving us which indicate that there is no reason why Saturn couldn't have been funded adequately within the Army. The Army was already doing an excellent job and had proven its success in the whole development program. What I would like to ask you is if you would comment on some of these observations and indicate whether we can pick up these pieces and proceed with the utmost speed toward the development of the other work that you have in the future. Would it be possible now to reverse this decision in your viewpoint?

General SCHOMBURG. I agree with everything that you say, sir. I think that all Saturn needed was money and it would have gone ahead, I am sure, just as rapidly as it could possibly go under any circumstances.

However, the decision was made and we are soldiers. Now that the decision has been made we are cooperating 100 percent. We will see that the transfer is made and that there is no delay in this very important program.

Since the decision is made and has gone this far, I don't know. This Von Braun team has a tremendous space capability and I would say, again, as I said earlier, the concern I would really have is that the Army did contribute to this team a most unique management and support capability. This is something that was almost as unique, in my opinion, as the team itself.

This capability does not transfer.

The CHAIRMAN. Mr. Daddario?

Mr. DADDARIO. General, exactly what will happen when a Nike-Zeus missile comes together with an incoming nuclear warhead?

General SCHOMBURG. This, of course, borders on some things that cannot be said in open hearing. But as General Trudeau said yesterday, the Nike-Zeus warhead has a capability of completely destroying the incoming ICBM nuclear warhead, without the ICBM or IRBM warhead going off. The Nike-Zeus warhead will be capable of destroying, with its own nuclear warhead, the incoming IRBM or ICBM warhead, but this will occur high enough above our own land that it should not in any way damage anything on the ground.

Mr. DADDARIO. And there is opinion, however, to the contrary to this, is there not?

General SCHOMBURG. No, sir. I don't know of anyone who would disagree with that. I don't think the scientists or any other technical people disagree.

The CHAIRMAN. Mr. King?

Mr. KING. The installation at Redstone is much broader than the Von Braun team. Could you just refresh our recollection on what will remain after——

General SCHOMBERG. Yes, sir; let me tell you what is at Redstone. The Army Ordnance Missile Command has four main parts, two of which are Agencies; the Army Rocket and Guided Missile Agency, which, for example, handles the Nike-Zeus as one of its important projects; and the Army Ballistic Missile Agency, which handled the Jupiter, which handled the space work, which handles the Pershing and these other oncoming ballistic missile systems. This Army Ballistic Missile Agency is a part of the Army Missile team and included the Von Braun group. So they will lose that group. The management that we have there remains with us, but it is my job to reestablish the in-house technical knowledge that will allow us to do the Army job in the typical Army fashion. This is the Army Ballistic Missile Agency. We lost only a part of that in the Von Braun group.

In addition to ABMA and ARGMA, we have what is known as Redstone Arsenal. This is our geographical name for the whole installation, but Redstone Arsenal is also a support organization. This is the agency that does all of our finance and accounting. It takes care of our supply. It takes care of our utilities. It takes care of the roads and grounds. This is the support agency that takes care of all the technical people there—this stays with us. We will give cadres from this agency, from my headquarters, from the others, to NASA, so that they can build a competence to take care of the Von Braun team; but essentially they stay with us.

The other portion of AOMC, the fourth portion, is the White Sands Missile Range. This is, of course, down in New Mexico, a thousand miles away, but also a part of this command so that we have full control of the testing of our Army missiles.

The CHAIRMAN. Mr. Roush?

Mr. ROUSH. General, do you feel that we have gone far enough with Nike-Zeus in its research and development phase to warrant going into production?

General SCHOMBURG. I certainly do, sir. I would answer about this way: I have full confidence in Nike-Zeus at this time. We feel we have as much confidence or even possibly more confidence in Zeus at this time than we had at the time in Nike-Ajax, when we put Nike-Ajax into production.

Mr. ROUSH. Do you feel we should spend that $137 million—are we limited to one question?

The CHAIRMAN. Yes, you are limited to one question on this first go around because General Medaris will be here at 10:30. However, I think all of us would like to know what your answer would be to the question about the $137 million, General Schomburg.

General SCHOMBURG. Well, the figure of $137 million resulted from a study which was made last year to determine the least amount of money we could commit or obligate during fiscal year 1960, that is

starting July 1, 1959, which would prevent any slippage in the earliest possible date of operational availability for the Zeus system. The $137 million is the lowest number of dollars that could be applied in the production area, or for preproduction preparations, which would prevent a slippage in the Zeus program.

The Army has been funded for Zeus research and development, but the needed funding for production has not been forthcoming. If you do not begin on production before you complete your development program, then you delay the time when you can actually use the system which is being developed. This is happening to Zeus.

Since the $137 million was not available to start production or preproduction on July 1, 1959, we have already lost, forever, 7 months in the operational availability of the Zeus, our only antimissile system.

And of course this $137 million would have to be followed by production funding in fiscal year 1961 and succeeding years.

But we are now losing 1 day that we could have Zeus on site, defending the United States against IRBM and ICBM attack—day by day we lose 1 day of Zeus operational availability for every day we delay in starting to use that $137 million.

The CHAIRMAN. Mr. Chenoweth?

Mr. CHENOWETH. General, you indicated you were losing the Von Braun group. They are still going to be at the Redstone Arsenal?

General SCHOMBURG. They will be there; but, of course, they will not be under our control, and any work that they would do for us is not on our priority. Future work, as I mentioned earlier, will be on a catch-as-catch-can basis.

Mr. CHENOWETH. But you will still be on speaking terms?

General SCHOMBURG. Completely on speaking terms. This is going to be one of the most friendly relationships, I assure you.

The CHAIRMAN. Mr. Quigley?

Mr. QUIGLEY. No questions.

The CHAIRMAN. Mr. Miller?

Mr. MILLER. Right now, I haven't any questions.

The CHAIRMAN. The gentleman lost his turn, then.

We have been around the full committee.

General Medaris is here——

Mr. MILLER. Is this the second time around?

The CHAIRMAN. Yes. The committee will recess for 3 minutes and during that time we will have General Medaris here and give the newspapermen any opportunities that they may wish to take pictures of our distinguished witnesses.

If you will tell General Medaris we will be happy to have him.

(Short recess taken.)

The CHAIRMAN. The committee will come to order.

Now, General Medaris, we are happy to have you here this morning. I told the newspapermen if they wanted to come and make some pictures of you and General Schomburg, to do so before we got started with your statement. I assume that they have made the pictures.

General MEDARIS. That is correct, Mr. Chairman.

The CHAIRMAN. We are happy to have you. We welcome you to the committee. We haven't had you since last year. We were glad to have your appearance then. Now, you come to us in a new capacity as a retired officer. You have quite a statement here. I think that

the committee would be very anxious to hear your views on the matters that are vital to this hearing.

Incidentally, we are swearing all the witnesses, General, on this particular hearing, the posture hearing.

Do you solemnly swear that the testimony you give in this proceeding to be the truth, the whole truth, and nothing but the truth, so help you God?

General MEDARIS. I do.

The CHAIRMAN. General, if you will proceed with your statement, then, we would be very happy to have it.

STATEMENT OF MAJ. GEN. J. B. MEDARIS, U.S. ARMY, RETIRED

General MEDARIS. With your permission, Mr. Chairman.

Of course, it is a great honor to speak to you gentlemen of this committee again and because I understand the time before this committee is limited I have selected two particular subjects to which my opening remarks will be addressed. The first is general, and has to do with my views with respect to our national missile and space effort. The second subject which I will consider is specific, and deals with my opinion as to the urgency of our requirement for an operational antiballistic missile system. Incidentally, it is both unusual and fortunate that this divided effort finds unity within the responsibilities of this particular committee.

In assessing the U.S. missile and space program, I believe we must first consider the character of the gross United States-Soviet competition. Fundamentally, I believe it is a clash between different philosophies as to the position of the individual in society. The field of conflict then is so broad, so profound, that it encompasses every element of international power—military, economic, diplomatic, political, psychological, and spiritual. Clausewitz observed that in human conflict the moral is to the physical as three is to one. Our strength must therefore be at least three parts psychological.

Now, I do not want to belittle the material benefits that may accrue from aggressive space exploration. I do not want to pursue in detail the self-evident fact that material benefits inevitably derive from new knowledge. Nor do I want to press the point that the military implications of a new principle or environment are never understood until that principle or environment is itself understood.

Without considering these corollary reasons, I want to affirm my personal conviction that for psychological reasons alone the free world must attain and maintain no less than parity and preferably a margin of superiority in the field of space exploration and exploitation. I consider the decision to achieve that parity—and eventually superiority—one of the most critical and fundamental decisions of our day. If the "space race" is not a valid one, then I would suggest that we are already spending too much money and too much effort on it.

On the other hand, if the competition is as critical and as fundamental as I believe it to be, then we are faced with two possible solutions. Either we must spend more in dollars and effort; or, we must substantially increase the efficiency of our effort.

Now, let us consider the manner in which our national missile and space program is presently splintered. First and most importantly:

it is divided between two executive departments: National Aeronautics and Space Administration and the Department of Defense. Functionally, it is splintered into four agencies, NASA and the three branches of our armed services.

Within the Department of Defense, a recent directive from the Secretary has revised the missions of the respective services. Both the developmental and operational aspects of space vehicles have been assigned as missions to the Air Force. A navigational satellite system has been assigned as a mission of the Navy. A communications satellite system has been assigned as a mission of the Army. On the surface, perhaps this decision pretends to settle old issues. Actually, in my opinion, it creates dissention.

By direction, the Army and the Navy are to buy their space vehicles from the Air Force; however, there is no immediate knowledgeable authority responsible for the overall mission. The problem of wedding the payload and the vehicle must be settled by such anemic devices as committees, coordination offices, and other such inadequate administrative devices.

Mr. FULTON. Hear, hear. [Laughter.]

The CHAIRMAN. The general is not referring to congressional committees, I hope.

General MEDARIS. I certainly am not. The function of congressional committees is quite well understood and is quite different from the operating functions to which I refer.

Mr. HECHLER. And they are not anemic.

General MEDARIS. And they are not anemic, Mr. Hechler.

There is in this case no technically competent authority sitting astride both the vehicle program and the payload program to give a joint program the decisive drive that success demands. In theory, system coordination has been assigned to the Air Force; but this, if authoritatively exploited, denies to the responsible service full control over its assigned operating space mission. Since no one authority is totally and immediately responsible for the complete mission, what is everybody's business ends up being nobody's business.

Let us now turn to the creation and continuing expansion of the National Aeronautics and Space Administration. The presumption that has apparently been accepted that the borderline between scientific space exploration and military space requirements can be cleanly and effectively defined. Gentleman, I believe this presumption to be totally incorrect.

From a purely technical viewpoint, there is so little difference between civilian and military space programs that there is no justification for their division and resulting duplication. For example, in the area of powerplants, both programs are concerned with a reaction-type engine, liquid or solid, whose functioning requires rather sophisticated control. This is a fundamental characteristic of every vehicle, whether it be a short-range ballistic missile used by troops in the field, or a more ambitious vehicle used in an interplanetary probe. Their development and operation stem from identical technologies.

Not only are the power sources themselves fundamentally identical, but the control methods, either on board the vehicle or those located at ground stations, come from common parents. I can give you as

many examples of commonality between the military and so-called civilian systems as there are components of their respective systems. For added example, in both programs, it is necessary to explore ways of getting dependable electronic propagation from a supersonic vehicle, getting antenna patterns, the effects of boundary layer, heat and velocity, and so forth.

All of this knowledge is essential to the development of any missile or any space vehicle. Also, there is a common requirement for guidance systems that perform identical functions. The same thing is also true in terms of dependable long-range communications to and from missiles and space vehicles. Further proof of the principle is offered in the use of smaller ballistic missiles as upper stages of larger vehicles.

Even from the standpoint of pure science, gentlemen, these programs are interrelated. Scientific exploration is in no way inconsistent with military objectives. New military technology inevitably results from scientific findings. An examination of the many projects contained in the research and development programs of the Department of Defense would indicate clearly that the military is supporting and fostering fundamental research insofar as its limited resources will permit.

There is a final consideration on this subject that I believe to be particularly cogent. The military objectives and the civilian programs, with very limited exceptions, are and must continue to be, derived from the same physical and manpower resources. Every single engineering and production facility that is involved in any kind of important space project is either now involved in or has been involved in one or more missile projects. This includes both commercial and governmental resources.

Further, the exploration and exploitation of space will continue to demand the use of the same facilities and the same brainpower that are now being used in the development of weapons systems.

Again, the list is endless and complicated, but the principle is brief and simple: We are trying, gentlemen, to divide the indivisible.

I quite well understand that because of the pending transfer of the Von Braun team from the organization which I have commanded, this criticism may sound like sour grapes. May I dispel that presumption by saying flatly, that under present circumstances, I concur in the transfer.

Mr. FULTON. May I congratulate you.

General MEDARIS. Thank you, sir.

In the area of political competition for control of resources, the Army has done the only thing it could do. When one is forced into making a choice from a bundle of bad choices, he must take the least objectionable one. The transfer of the Von Braun group to NASA is the unfortunate culmination of a long series of such dilemmas. At the end, the Army faced a Solomon's choice: First, by the assignment of the space vehicle development, production, and launching mission to the Air Force, and secondly, the Army's total inability to secure from the Department of Defense sufficient money or responsibility to do the Saturn job properly, we found ourselves then in the position of either agreeing with the transfer of the team, or watching it be destroyed by starvation and frustration. However, gentlemen, this

particular issue of the transfer of the Von Braun team is only one small part of the issue before you, the issue I hope to put before you.

Now, of course, good men working hard together can make any form of organization work after a fashion. The purpose of sound organization should be to reduce the requirements for coordination and cooperation to a point where they are reasonably consistent with human nature and the capabilities of the average executive group. With sound organization, coordination and cooperation become the natural product within the organization. Thus only, may we avoid the sort of hothouse nurtured or blackjack inspired coordination that presently seems to be the order of the day. People after all are human. The only way that we get the best effort out of any individual, no matter what his size or stature, is to so place him that in furthering his own intelligent self-interest he is at once furthering the objectives of his organization, and hopefully, of his country. This is the sort of organization to which we must work.

There is a further reason why the present trend is illogical and I believe undesirable. The Von Braun group has been supported extensively by a nationwide Army organization which must continue for the performance of Army missions, regardless of whether the Von Braun group goes or stays. You cannot expect to create a new and separate system to support them in terms of finance, accounting, purchasing, inspection of purchased products, contracting for services, and the provision of general logistic resources and facilities, without spending additional money.

I understand that this issue is now academic, but the Congress has continuously beaten the Department of Defense over the head in an attempt to unify those same activities, and thus reduce the duplication among the three military departments. By the existing organizational concepts and the operational responsibilities placed on NASA, NASA must necessarily proceed to create its own system for all of those things—a system which already exists in triplicate—Army, Navy, and Air Force.

Now, for all of these reasons, I believe, that if we are to compete successfully without bankrupting the country, there must be a fundamental organization unification of the entire missile and space program. One asks immediately, How can this be done and where?

It is unrealistic, and, I believe, an obviously improper division of responsibility to take outside the Department of Defense the responsibility for weapons that are essential to the performance of the mission of that Department. However, and particularly in view of past performance in areas of purely civilian activities, such as the work of the Corps of Engineers in rivers, harbors, and flood control, the work of the Signal Corps in operating the Alaska Communications System in the absence of a commercial capability to do so, the administration by the Army of the Panama Canal, and many others, there is nothing fundamentally inconsistent in assigning civilian scientific efforts in a particular field to the Department of Defense.

Thus, in view of the fundamental inconsistency involved in taking the responsibility for weapons development out of the Department of Defense, we are forced to conclude that the space effort, if it is to be unified, must be unified within the Department of Defense.

Now, how can this be done? If we look with discerning eyes, Congress itself has pointed the way. In the most recent amendments

to National Defense Organization, it is evident that Congress intended an extension of the principle of the joint unified command composed of elements of the several Armed Forces. By its enactments, the Congress gave to those joint commands a substantially greater degree of independence from the individual services than such commands had ever before had. They strengthened the staff of the Joint Chiefs of Staff, and set up the commands to operate with direct channels to the Joint Chiefs and to the Secretary of Defense. So far, this concept has been applied almost exclusively to geographic operating areas. These are now almost entirely handled through joint commands. While this is as far as this concept has gone to date in its broadest applications, it has been also applied to an important degree in atomic weapons through the charter of the Defense Atomic Support Agency, known as DASA.

DASA offers us a tested pattern for the problem that faces us here. It would appear there is nothing to deny the possibility and the desirability of creating a joint command to assume the undivided responsibility for the major missile and space activities of the Nation. Each service, being fully represented within, and dependent upon the command, would necessarily feel the compulsion to support its representatives in the joint command. Through that medium and that fact, the availability of the various supporting elements of the several services to smoothly and competently reinforce the joint effort would be assured. In order to assure adequate attention to the scientific side of space exploration, the scientific community should be represented at the command level. Thus, we would aline individual and national objectives.

In substance, gentlemen, I am recommending that this committee and the Congress take a broad new hard look at the organization of our resources to meet our needs in missile and space activities and give thorough consideration to the suggested course of action, or any other, which will achieve with assurance a solid, undivided, and effective approach to the solution of our most urgent need.

In concluding these remarks with some consideration of our need for a ballistic missile defense system, and particularly of the present position of the Zeus system, I want first to deal with that school of thought which argues against the need. In this connection, I should like to rephrase an old cliché: When offensive capabilities are equal, then the best offense is a good defense. We have a positive deterrent only when we can do something that the aggressor cannot do.

There is no denying the requirement for an assured retaliatory capability. It serves as an effective deterrent against all-out, massive, and sudden annihilation. If its purpose is achieved, gentlemen, it will never be used. Conversely, if it has to be used, it has failed in its purpose.

For a deterrent force to be fully effective, it must have certain characteristics. It must be powerful enough that the damage certain to be inflicted would be wholly unacceptable to the aggressor power. Second, it must be supported by the unquestioned public will to use it if necessary, and without delay. Third, the potential aggressor must know with certainty that the two foregoing conditions do exist.

Certainly, the deterrent force must not be made ineffective by the very act it is designed to prevent. Now, within the military there are many ways to achieve this relative invulnerability. Being military,

the direct retaliatory capability is subject to military discretion. It can be hardened, dispersed, hidden, and made mobile. It can simply be multiplied to the extent that the aggressor cannot completely destroy it in a single blow. This is a technique which we understand and can apply.

However, it seems to me that there would be little sanity in destroying half of Russia and Asia, if before such destruction was meted out, the major populations of the 20 largest cities of the United States had suffered massive damage and wholesale slaughter. It would be nothing more than revenge. There would, in fact, be little left for us to fight for.

What are we going to do with those cities—with New York, Chicago, Pittsburgh, Cleveland, and Detroit? They cannot be effectively hardened, dispersed, made mobile, depopulated, nor forgotten.

Passive means of defense have very real limitations. By the nature of economic circumstances, if for no other reason, it is unrealistic even to consider adequate hardening as a protection for the physical resources from which stem our industrial and economic strength. In the cold and pitiless light of pure logic, we must therefore find a means for their defense against sudden and massive annihilation. This has been adequately recognized in the development and deployment of missile systems to protect these centers from air attack. To the more formidable threat now rising we have only one present answer.

The Nike-Zeus antimissile system now in development, is our only conceivable positive defense for the next decade. While better means may be discovered in the future as a result of active research, the nature of those possible means is not nearly sufficiently and clearly known at this time to warrant the commitment of resources to the development of any other systems. Given the essential leadtime required for the genesis of any such complex defensive system, any really new approach cannot, in my judgment, be available for use before 1970. Meantime, the millions of inhabitants of our concentrated centers live with a sharp and cruel sword poised over their heads and held only by the gossamar thread of our opponents's nationality.

At the same time, gentlemen, it is a certain fact that every day we delay in initiating the series of complex actions required to commit the Zeus system to production will delay by an exactly equal period its availability for use.

Admittedly, there are development problems still to be solved, but far too much has been made of them as a negative point. They exist in all development programs. Otherwise, there would be no need for any such program, and we could go directly into the production of a new weapon. I assure you that those technical problems are proportionately no greater in the Nike-Zeus system than they have been, or are in other weapons systems of great cost and importance. The immediate, discernable problem of straightforward defense against straightforward ballistic missiles, IRBM or ICBM, is in my opinion fully in hand. I am further convinced that additional defense against more sophisticated weapons can and will be solved at least as fast as any such more sophisticated weapons can be brought against us.

Now, in other complex and urgent programs, great virtue has been ascribed to the technique of integrating development, initiation of production, training, and the preparation for deployment. In fact, the term "concurrency" has been widely advertised as representing a virtue. Such telescoping of all phases substantially shortens the lead-time to availability, and, therefore, carries assurance against the obsolescence of the weapon itself before it can be brought to bear.

Gentlemen, I am at a total loss to understand why it is not equally obvious that this same procedure is essential in connection with a weapon of such tremendous importance to our survival as is the Zeus.

In essence, I believe that the question is not whether we have yet completely demonstrated the full effectiveness of the Zeus system, but rather, whether we are to make any effort to defend the major centers of the United States against atomic annihilation by ballistic missiles during the next 10 years. I feel very strongly that we cannot afford not to initiate immediate action looking to the prompt production and deployment of the Zeus system. The absence of a decision is in itself a decision. To fail to order the immediate preparation for production of this essential defense system is to add days, months, or years to the period when fear must hang like a cloud over our civilian population. To do otherwise than to take this action immediately represents, in my opinion, the assumption of an awful and a burdensome responsibility—a responsibility for the survival of the women and children, as well as the men, in the population of our great cities, upon whom in large measure both the prosperity and the will of the United States to survive as a nation depends. I for one am wholly unwilling to have that responsibility on my conscience.

Gentlemen, the entire field being considered by this committee is extraordinarily broad and complex. Giving full consideration to the influence of technology on the strength of this Nation, and on those elements which go to make up that strength, the decisions to be taken are, in my opinion, of vital importance to the future of this Nation, and, indeed, to its very survival as a free nation. I could not hope to cover even a fraction of the problems involved, let alone discuss all elements of their potential solution within the scope of this comparatively brief statement to you. I have tried, therefore, to single out two areas as being, in my opinion, of the greatest significance at this particular time.

To summarize, then, my carefully considered feelings with respect to those two areas, I should like to conclude with these brief statements:

Firstly, I do not believe we can afford not to compete, with all the necessary ingenuity and resources, to demonstrate to the free world both the capability and the will of this Nation.

Secondly, I feel that because of its prominence in the public mind of all nations, the field of space activities has become a most critical element of that competition, and that we, therefore, must have an aggressive and urgent national program to attain and maintain no less than equality, and preferably, demonstrated superiority in that field.

Thirdly, I believe strongly, and feel that it is wholly demonstrable, that the fields of ballistic missilery and space exploration and exploitation are in fact naturally indivisible elements of a single broad technology, and that a continuance of divided efforts in this broad area

cannot but result in delay, duplication, and waste of both money and manpower.

Fourthly, I believe that any pretense toward the deterrence of atomic general warfare must necessarily be ineffective unless it includes the effective protection of our population and our major resources, and thus assures the survival of our will to live as a nation. I further feel that to delay the full acceptance of that responsibility, regardless of the uncertainties that may exist, involves a risk far too great to be accepted by any individual who can in any way influence that decision.

I therefore strongly recommend that this committee give full consideration to the means for the creation of a truly unified and singly responsible authority for the direction of the national missile and space effort, and that it further recommend immediate preparation for the production and deployment of the only visible means for the protection of our population against the awful threat of atomic ballistic missile destruction, whether medium range or long range, sea-launched or land-launched, that is represented today by the Zeus antimissile-missile system.

Thank you for your forbearance, Mr. Chairman and gentlemen. I shall be glad to answer any questions.

The CHAIRMAN. Thank you very much, General, for your statement. I might add that it is a very potent statement.

Now, at this time I have just been looking over the committee. We have some 18 members here and we have the subcommittees meeting at 2 o'clock. We have an hour for questioning of these two distinguished witnesses. If there is no objection, why not set 3 minutes per individual and that will insure that we get around to everyone on the committee? Is there no objection to that?

Mr. TEAGUE. That is fine. Let's get started.

The CHAIRMAN. If not, we will do that. I will watch the clock and I am just going to take 3 minutes, myself.

General Medaris, I would like to ask you this question: There is $137 million stashed away somewhere that has been appropriated by Congress for the Zeus program. If you had your way, do you think there is justification for releasing that money to use in the furtherance of the Zeus program?

General MEDARIS. Mr. Chairman, I so recommended months ago. I believe it should have been released immediately that it was available through the action of the Congress.

The CHAIRMAN. May I ask you also this question now: If you had a Manhattan type project, for instance, for the Zeus and you were in charge of it, what would specifically be your action in pushing forward that project?

Would you outline that in detail to this committee?

General MEDARIS. Well, the immediate requirement, if we are to meet any kind of a time scale in the deployment of Zeus, the immediate requirement, now overdue, is to begin to create the production resources that will be needed to make the system effective as a deployed system.

Now, we can build the requirements for the Zeus system from a development standpoint by hand, as they are practically being built today.

But when you consider, for example, the single requirement for a million transistors in one particular building, one part of the Zeus system, you must know that our present resources could not possibly meet this requirement.

Therefore, it is necessary, as one single example, that automated means for the production of these transistors be available before we can turn to the deployment of the Zeus system.

Now, the lead time for such a situation is long. That must begin immediately. In our best judgment when we had made the most detailed computations possible in connection with our prime contractors and with their assistants, we came up with the conclusion, and I believe it to be thoroughly valid, that from the day money is released to begin preparation for production, you are "X" years away.

I leave the figure out because I believe this to be a classified figure. But you are that many years away from having the first system that can be used in defense of a specific point.

Now, it is essential before that date can be fixed that these actions begin. The actions necessary to make it possible to produce the Zeus system and put it on site, as distinguished from the resources which are capable only of producing it in an R. & D. fashion, one at a time over a period of considerable time.

The CHAIRMAN. But your $137 million would not cover that? Your $137 million is for engineering, isn't it?

General MEDARIS. No, sir; this would cover a part of it. The $137 million, if employed immediately that it had been available, would have taken care of approximately the first 12 months of all of the activities required to maintain this schedule and could have been followed by a succeeding appropriation the following year, which would, of course, have been greater, to continue that work.

The CHAIRMAN. Mr. Fulton?

Mr. FULTON. Glad to have you here, General.

Now the question—I have to give you a short area of reference or statement in order to couch my question. The 85th session of Congress decided unanimously both in the Senate and House that space should be entered by peaceful means for peaceful purposes.

The President signed it. The United Nations set up an ad hoc committee, and I was a delegate for the United States second to Henry Cabot Lodge. It was unanimously decided by the General Assembly that space would be used for peaceful purposes.

You at one time said every time man puts his foot anywhere he ends up with a war. So I would imagine you must mean the same thing for space. Then when on February 1 in "Missiles and Rockets," you had said, or you are quoted as saying by James Baar whom we all know that you—

Raked the civilian-military separation of U.S. space programs as "fundamentally unrealistic" and called for creation of a single missile-space agency—a joint military command.

You would put it inside the Pentagon as a joint command. Then saying—

The only excuse for NASA was to take projects from the competitive area. But a joint command would do the same thing.

Here is my question: There have been two very successful space programs and missile programs. One of them has been conducted by the United States of America.

The other has been conducted by Soviet Russia. Soviet Russia has had a peaceful approach to space because they put it under civilians—call it a civilian approach rather than peaceful. They have it under an academy of sciences.

Nesmeyanov is the president of it. Likewise, they have as their head of the astronautics, Sedov, who is now the president of the International Astronautics Federation.

We in the United States have proceeded into space through the National Advisory Committee for Aeronautics established in 1915 and it worked beautifully for aeronautics. Now, with that as a preface, why should we leave two successful programs and go into a program placing it thoroughly under the military and stifling the scientists by making them come up with weaponry systems rather than use space for peaceful means which is the settled decision of the Congress of the United States?

You say you are in the minority. It seems to me you are in a very small minority. Would you answer?

General MEDARIS. Yes, sir; with due apologies, Mr. Fulton, since you have now given me your feelings in the matter, I have to enter the opposition.

I feel that the situation in Russia has been misinterpreted. It is titularly under civilian authority from the scientific angle but the organization throughout from top to bottom is welded as between civilian and military and there is no separation of the activities and the resources are used in common by both, all programs.

Mr. FULTON. That is what I want us to do.

General MEDARIS. I beg your pardon. The organization is welded together so that it does not function as separated organizations until it becomes either an operating weapon or something of the sort and is taken out into the wholly military channel.

Now, my only reason for recommending that the effort be unified under the Department of Defense is because of the illogic of having weapons outside the Department of Defense. If there is another way outside the Department of Defense to bring together all of the resources under a single direction, I would not object to it.

The CHAIRMAN. Mr. Miller.

Mr. MILLER. General, I was very happy to see you make a reference in here to the necessity and immediate necessity for a defense of the women and children of this country in the civilian population through the development of the Nike-Zeus system to give us at least some defensive capability against it.

Do you believe as I take it that this is the best system that we have devised to date?

General MEDARIS. It is the only system on the horizon to date, sir.

Mr. MILLER. And you are convinced that it is time to go into production on that system now, we are far enough along with it that we can go into production with it now?

General MEDARIS. It is my best technical and managerial judgment that we are past the time that we should have put it into production.

Mr. MILLER. So every day that we delay going into production on that, we just weaken our own fiber in the case of war?

General MEDARIS. Of course. We delay by 1 day the capability to provide any protection for the civilian population of this country.

Mr. MILLER. Thank you, that is all.

The CHAIRMAN. Mr. McDonough.

Mr. McDONOUGH. General, I appreciate your statement. It is to the point and undoubtedly will have quite an impression on this committee's consideration. I am curious to know if you would be as positive in your views if you were still in uniform?

General MEDARIS. I have been equally positive, Mr. McDonough, in my views as expressed within the conferences inside the Department of Defense.

Mr. McDONOUGH. You have made some very definite statements here and I appreciate them as coming from a loyal American. But having had command of the very area in which you now recommend certain changes. I am surprised that these changes were not put into effect while you were there.

General MEDARIS. They were recommended, Mr. McDonough. The recommendations came to nought.

Mr. McDONOUGH. Now, insofar as Nike-Zeus is concerned, is it your opinion that it has proved its capability to the point that it is the only deterrent that we have, effective deterrent that we have at the present time?

General MEDARIS. There are two clear points, sir. One is that the present status of the engineering of the system, the theoretical work and the ground test work that has been done is sufficient in my opinion, to clearly demonstrate that the forthright and straightforward defense against ballistic missiles is a capability of that system as it will come out.

And, further, the engineering means to that end are sufficiently advanced to point clearly the direction necessary to prepare for production without requiring any costly alteration at a later date.

So that whatever growth potential may be put into it as we go along, can be added to the present system and will not change the basic formula.

It is further my conviction and so far as I know, not disputed, that there is no other effective defense now known to be feasible.

Mr. McDONOUGH. What about the test we made in New Mexico just recently? That wasn't a Nike–Zeus test, was it?

General MEDARIS. We have been beginning the testing of the missiles in New Mexico.

Mr. McDONOUGH. The Sparrow and the Little John that we shot off——

General MEDARIS. This was the Hawk that we shot against the Little John.

Mr. McDONOUGH. That is right. What about the Bomarc?

General MEDARIS. The Bomarc has no antimissile capability nor was it designed nor intended to have. The Bomarc is an air supported weapon. It cannot go outside the atmosphere to meet an incoming missile before it reenters the atmosphere.

Mr. McDONOUGH. You think the Nike-Zeus is the only long-range antimissile possibility?

General MEDARIS. On any kind of ballistic missile, it is the only thing on the horizon at the present time.

Mr. McDONOUGH. Do you have any knowledge that Russia has similar plans or programs or do they have anything in a practical way on missile attack?

General MEDARIS. I want to be quite careful in this area because of course, I still feel the same responsibility for the protection of security that I always have. I can simply say that I feel quite sure in view of what we do know and in view of what we know about past developments they have come upon us when we have recognized them, as being in the hands of the Russians, we are wholly unsafe at any time to assume that the Russians do not have the capability of doing anything that we are capable of doing.

The CHAIRMAN. The gentleman's time has expired. Mr. Teague?

Mr. TEAGUE. General, I think you have made the most challenging statement that has been made before this committee in all the hearings we have had.

I think only history will tell whether you are right or wrong and I for sure, am going to put your statement in the record so it will be recorded.

As it is said, you are in the minority. But I think that over in the Defense Department, you are on a team and when a decision is made, you have to play on that team.

General MEDARIS. Correct.

Mr. TEAGUE. When you come over here, you are on a bigger team and you ought to play on that team. I was disappointed, as far as I personally was concerned, I asked a question directed toward this problem, to General Schomburg and I think he ducked the question.

My question to you is if you were all powerful in our whole missile program, what would you do as far as all our different programs, the Atlas, Titan, Minuteman, Bomarc, all the rest of them?

General MEDARIS. Well, within the time limit the Chairman has imposed on these remarks, I will have to confine myself to this——

Mr. WOLF. I would happily yield my 3 minutes to give him 6.

The CHAIRMAN. The gentleman is out of order. He can't yield. Just proceed, General.

General MEDARIS. Thank you, sir.

First of all, I would have created long ago a joint command to operate this area, and secondly, I would have killed certain programs in order that within the present budgetary limitations, we might do fewer things and do them better.

Mr. TEAGUE. Which ones, General?

General MEDARIS. Well, I would have killed the Snark a long time ago.

Mr. TEAGUE. Name the rest of them.

General MEDARIS. I am not going to have any friends when I get done, Mr. Chairman. [Laughter.]

Mr. TEAGUE. You will have some friends in this committee, General.

General MEDARIS. I personally killed the Dart inside the Army. I would have killed the Bomarc because it is a weapon that is to be available when, by intelligence estimates, there is no longer a threat that it is capable of dealing with.

I have not had the opportunity nor the time to examine in detail between the Titan and Atlas and the Minuteman. I know something

of all of their characteristics and can appraise them reasonably, but certainly three is too many. Those actions certainly would have provided up to date a sufficient amount of budgeted funds to have given us the kind of support for an aggressive program at full speed in both Zeus and the space program.

Mr. TEAGUE. General, one other question. You are in the minority. How much minority are you in? How many people do you know, not naming them, but generally, what support do you have for your thinking as to whether or not we build our missile space program on sand or whether we are on a solid foundation?

General MEDARIS. Sir, I can only comment that within the evening councils of the renegades of our business, I have a great deal of support. [Laughter.]

The CHAIRMAN. Mr. Chenoweth——

Mr. FULTON. May I have a unanimous consent request?

The CHAIRMAN. That is in violation.

Mr. FULTON. Consent request. I would like to put in the record at this point the statements of the Atlas, Thor, and Minutemen generals in——

General MEDARIS. Atlas, Titan, and Minuteman.

The CHAIRMAN. It ought to be done afterwards. Mr. Chenoweth?

Mr. CHENOWETH. General, I am happy to see you again. It has been about a year since we saw you down at the Redstone Arsenal there. I have formed a very favorable impression of what I saw down there, General. What is the impression we want to give to the American people today? That we are in a rather defenseless, helpless condition here after having spent some $400 billion on defense?

What is the picture we want to tell the people? Is it a defeatist attitude or must we take an affirmative attitude?

General MEDARIS. We must take an affirmative attitude. On the other hand, I can see no virtue in soothing syrup, as such. The point is there is always a difference between our present situation and the situation as it will develop if nothing is changed. In dealing with these programs, we are dealing with an inescapable factor of leadtime, Mr. Chenoweth, and I am concerned with what is going to be the situation 5 years from now.

I do not think we are in a defenseless situation today. I think perhaps we could be better off, but we certainly are not badly off.

Mr. CHENOWETH. You are telling this committee and the country some mistakes have been made?

General MEDARIS. I believe some mistakes have been made, but I believe if we do not change our approach to the future we will have worse ones, and I think that the situation of 5 years from now should be of greater concern to us at this point than the present situation about which none of us can do anything.

The present situation is in the wood. Now we can only do things that may constructively give us a better situation 5 years from now than we would otherwise have.

Mr. CHENOWETH. General, in years gone by we have had the capacities and the leadership and know-how both in civilian and military leadership to solve these problems as they have come before us. Shall we confess now that we are no longer capable of making the right decisions in these important matters? What is our situation? I don't

know. I think the American people are getting a little concerned over this.

General MEDARIS. I should imagine they would be—and I am with them. [Laughter.]

Mr. CHENOWETH. We had better make up our mind here what we are going to do. I recall when we were in Redstone last year that you were a little critical of some of the things that were going on; you weren't getting enough money.

But I just can't sit here and believe that this thing has been an overall, colossal, complete failure. I don't take that as my view——

General MEDARIS. I do not pretend to insinuate that that has been the case.

Mr. CHENOWETH. I know you don't, but the people are getting false impressions of what is going on, they hear one charge, then a countercharge the next day, no wonder they are sometimes bewildered——

Mr. TEAGUE. Sometimes.

Mr. CHENOWETH. So I think we should take a positive and factual approach in what we are going to do. I think you have done a great job in the Army. I think the country recognizes that, General, and I think you can continue to do a great job in the civilian area, but I don't think it can be done all together in a critical vein. I think it should be a positive critical program, where you can lend your weight to what we are trying to do to save this country.

That is all, Mr. Chairman.

The CHAIRMAN. Mr. Sisk.

Mr. SISK. General Medaris, of course, we are happy to welcome you and I certainly want to concur with what Mr. Teague had to say in his statement. I want to explore a little different angle here in the brief time that I have and that has to do with a specific program which we are talking about. I would like to ask you about three questions here, very briefly. First, what in your opinion, does Russia plan on doing with reference to exploration of the Moon?

General MEDARIS. They have made the open statement—and if we consult history, what they promise us they usually produce somewhere along the line—that the 50th anniversary of the Revolution of 1917 would be celebrated by Soviet citizens on the Moon?

Mr. SISK. What do you think the United States, then, should be doing about exploration of the Moon?

General MEDARIS. My own personal feelings are very strongly in the direction that we should have begun sometime back the necessary long-range preparations that would lead to our capability of having a manned outpost on the Moon by 1966 or 1967.

I don't know that we could now make those dates, but we could still come awfully close to them if we went about it.

Mr. SISK. Has the Army ever made any proposals in this regard that would seriously compete with Russia?

General MEDARIS. The Army has made two such proposals to my knowledge.

Mr. SISK. When were they made?

General MEDARIS. The first was included in a document that was made up voluntarily by our group in the period between the firing

of Sputnik I and Explorer I, when a document was turned out which pretended to be an approach to a national space program. Included in that was lunar exploration and lunar landing.

This document used all the resources and all of the hardware that was available or could be made available. It was not a unilateral program all to be done by us, by any amount of means. That was the first such document.

Mr. SISK. To whom was this proposal made?

General MEDARIS. The proposal had no place to go officially, Mr. Sisk. We took it out and handed it to people that we hoped would do something with it.

It eventually became a feeder to a committee report of the NACA, who then began to see the shadow on the wall, they might have to interest themselves in space. [Laughter.]

General MEDARIS. And this committee used this document as a feeder report and it became, to a considerable extent, the basis for their first document outlining the possible national space effort.

Mr. SISK. That actually to some extent answered my last question which was what action was taken on this proposal, because I think it is of importance—in the first place you had a problem of actually to whom to submit the proposal.

General MEDARIS. This is correct, because we had—at no time did we ever have an assigned space mission. Therefore, we had no official capability to engender and propose a program on our own.

The CHAIRMAN. The gentleman's time has expired. Mr. Van Pelt?

Mr. VAN PELT. General, while down at Huntsville a year ago, you made a statement relative to men who had been in the service coming back and staying on the job as civilians.

Am I correct in that?

General MEDARIS. I don't recall it, sir. I am sorry.

Mr. VAN PELT. We were talking about the morale and it was along the point of maintaining our technical people and interest in some of those people who, like yourself, are so vitally interested in this program that they did come back, some of them, after separation from the service and continued in their——

General MEDARIS. I think if I recollect correctly now, Mr. Van Pelt, we were talking to the subject of conserving the capabilities that we had in general and I was pointing out both the positive and the negative aspects. That in the negative side the actions of the Nation, as represented by the Congress in terms of the restrictions placed upon their retired military officers, had effectively discouraged their participation after retirement in public activities, or as support to the industry in general.

At the same time I was pointing up the fact that at that point perhaps the council of elders that could be so composed might have some virtues. But primarily I think I was speaking to the point that it becomes very difficult for this to be accomplished under the present circumstances.

Mr. VAN PELT. Yes, I recall that. There was some mention of compensation as well in that area.

One other question. I would like your opinion as the morale of the Von Braun team and others connected with it, with this transfer? Has there been any change there?

General MEDARIS. I think the morale of the group at the present time, sir, is very high. This would be rather obvious if we put together a series of circumstances.

First of all, I was very frank with the entire group at the time this transfer was arranged and gave them as my frank opinion that this was the only way by which they could be in a position of having a positive mission and be able to go forward aggressively in the space area.

Secondly, since that time things have been done which we never managed to get done, in terms of increased funding for the Saturn project, which is the best bid we have at the present time, and, obviously, the agreement to add more money to that project and greater impetus to it is, in fact, a great morale factor.

So I would say at the moment that their morale is very high.

Mr. VAN PELT. Thank you very much.

The CHAIRMAN. The Chair is going to recognize Mr. Moeller at this time, because he has an urgent call to go home and he is going to have to leave at 11:30. I recognize you for 3 minutes.

Mr. MOELLER. Thank you, Mr. Chairman.

General, you may stand in the minority at present. I hope grace will be provided that you will be proved to be right. I would always rather be on the safe side.

While others have had the media of radio and television to expound their ideas, I think if this same were accorded you, you would find that the majority would be standing with you.

Now, the question I would like to ask you is this: As to cost, is it not true that a Nike-Zeus would cost us about one-fourth as much as, for example, a Titan? And if this were done, we could actually cut down considerably on the amount of money that we would be investing in intercontinental ballistic missiles?

General MEDARIS. I don't know that I can go with the exact proportion. It is difficult to cost the missile as comparative items, because, in the case of the Titan system, for example, the missile itself is the most of the weapons system. In the case of the Nike-Zeus, the major cost of the system is in the ground equipments and installations required to use the missiles, and the missiles themselves are less costly, of course.

The position comparatively on cost might be stated this way: If, in addition to protecting the civilian population, the Nike-Zeus system were used as a defense for our deterrent capability—for our counterstrike capability—it seems to me obvious that a lesser number of intercontinental missiles would be required to assure an effective counterattack, which would come out mathematically to cost less. I am not sure, but I think the advantage would be somewhat in favor of protecting our counterstrike capability with Zeus.

Mr. MOELLER. Thank you.

The CHAIRMAN. Mr. Bass?

Mr. BASS. General, you spoke earlier of the high morale of the Von Braun team. Do I understand from your prepared statement that we again investigate and reexamine the possibility of moving Von Braun and his team from NASA back under a single unified military command?

General MEDARIS. I am sorry, Mr. Bass. I think we have to put it in this kind of perspective: Under the present circumstances and

within any time lapse which would be required to consider the organization, it seems necessary, if delay is to be avoided, that the transfer go forward, and I understand that the House has already expressed its opinion in that direction.

To delay the transfer at this time would only further complicate an existing situation. What I am recommending is that a look be taken at the total overall structure with a view to possible revision which would not mean, necessarily, transferring them, because it would merely bring the whole together under a single organization, and would require no physical transfer.

I think it would permit some peeling back on supporting resources and, therefore, represent some economies. But this should be taken as a longer range picture to look at the total structure, because at the present time any attempt to stop the present action would, I think, have no merit.

I mean I don't think it would achieve anything.

Mr. BASS. Thank you for clarifying that point, General. We heard Dr. von Braun earlier and I got the impression, anyway, that all he wanted to do was to go ahead full steam and perhaps it would be a mistake to cause further indecision by subjecting him to the possibility of going back again under a different basis.

Now, my next question is a general one and is one that has been bothering me. In this age of missiles and other terrible weapons systems that we are developing, do you think, General, that it can ever be possible, now, for this country to enjoy military security in the way we did 40 or 50 years ago, no matter how many billions of dollars we pour into defense?

General MEDARIS. Well, I think our history has indicated that even then we didn't enjoy real military security, except that our civilian populations were then free of the immediate threat hanging over their heads, which now exists by reason of the development of the intercontinental ballistic missile system.

This is the major change, that there is now no place to hide, so everybody is in the game. As far as the Nation is concerned, there was no time when we enjoyed full immunity from the possibility of successful military attack, shall we say, and this has been demonstrated by the history of repetitive wars in which we have had to engage to make our position stand.

I do not believe that anyone who pursues positive security as an objective can ever achieve it. I do not think there is any such thing as 100-percent security. But that we can achieve at least an uneasy balance which will leave the problem of military security as one primarily concerning those whose business it is, and give confidence to the civilian population and the industrial values of our country, that they may go ahead with their business in the knowledge that the sentries are capably armed and on the job; I think this we can achieve.

The CHAIRMAN. Mr. Mitchell?

Mr. MITCHELL. General, as a fellow renegade, let me join you in the minority. [Laughter.]

General MEDARIS. Thank you, Mr. Mitchell.

Mr. MITCHELL. Now, you know the time limitation. I am going to ask you, if you will, to answer yes or no—give me your opinion to these brief questions, and if we do have the time, then you can elaborate.

Now, the transfer of Saturn to ASA; will that speed up the Saturn project? Let's forget funding, additional funding, the transfer from Army to NASA; will that speed the Saturn project?

General MEDARIS. Not without additional funding.

Mr. MITCHELL. Without additional funding, do you think it will slow it down?

General MEDARIS. It will make it a little more difficult to maintain the scale, but the scale can be maintained.

Mr. MITCHELL. Will it cost more money?

General MEDARIS. Definitely.

Mr. MITCHELL. Going to Nike-Zeus now, very quickly, General, let me say I think Judge Chenoweth mentioned something about the American people being bewildered. I am quite bewildered as to why we don't go ahead with Nike-Zeus full blast, myself.

I will ask you this: For how long a period of time do you think that the Zeus system will be an effective weapons system?

General MEDARIS. At least until 1970, considering its present position and its growth potential.

Mr. MITCHELL. Now, going into the growth potential, what is the growth potential of the Zeus system as you see it?

General MEDARIS. It has been designed from the ground up to be able to add those refinements and more effective methods which will deal with more sophisticated incoming weapons, within the capability of our view at present—everything that we know.

Mr. MITCHELL. You think it can deal effectively with the more sophisticated weapons?

General MEDARIS. I think by the time such sophisticated weapons could be brought against it that the Nike-Zeus can deal with them; yes.

Mr. MITCHELL. Thank you.

The CHAIRMAN. Mr. Riehlman?

Mr. RIEHLMAN. General, delighted to see you here today; and I recognize the sincerity and the manner in which you have presented your statement here and I appreciate your views.

Now, following what my colleague, Mr. Mitchell, has had to say, in respect to the Nike-Zeus, are you aware of studies that are now going on in respect to other weapons comparable to the Nike-Zeus?

General MEDARIS. I am.

Mr. RIEHLMAN. Do you feel that there is any merit to any one of them other than the Nike-Zeus?

General MEDARIS. I think we must necessarily continue such experiments with the constant hope that we might find something more effective in the future. As to the immediate present, none of them give promise of being immediately translatable into any system that would be better than the Zeus.

Mr. RIEHLMAN. But you would hate to see any one of them—the further research in respect to their effective striking power—discontinued?

General MEDARIS. That is correct.

In every field of activity, we not only must be about solving our immediate problem within our immediate technical capabilities but we should be doing even more than we are toward laying the basis for more effective work in the future.

This can only be done through continuing research.

Mr. RIEHLMAN. Back to one other question that my colleague from Texas, Mr. Teague, was pursuing. That is in respect to your feeling regarding some of these projects that should have been canceled out, and then you got to the Atlas, the Titan, and the Minuteman—some question in your mind whether those three should be now under consideration and production. Let me ask you this, General: How would we have gotten the Atlas—and now we are stepping up to the Titan and the Minuteman—how would we get into these programs and progress with them if we didn't put into production at least one missile? And then we are trying to move into others, take the Minuteman, for instance, as a solid fuel missile and one that we feel has greater potential than the Atlas.

Would you like to comment on that?

General MEDARIS. Well, I think one, and another generation if it shows sufficiently marked improvement—that this combination is warranted. All I said was that out of the three, it seems to me like that is one too many.

Now, I would like to point up, however, a particular view of my own with respect to the matter of obsolescence and greater efficiency.

I cannot see that greater efficiency, for its own sake, is of value to the taxpayer who has to pay for it.

If we have a weapon that can effectively do the job the man who gets hit with it isn't going to have the vaguest idea whether it was 120 feet tall and weighed 200,000 pounds or whether it was 60 feet tall and only weighed 50,000 pounds.

So that I think we must guard against upgrading, so to speak, our weapons systems simply for the sake of doing something that is apparently technically more perfect. If the system will do what it was intended to do, it need not be replaced nor upgraded.

Only when it becomes a system that cannot do its original job because either a defense is available against it or it is outside of its capabilities of reaction time, then we should do something better.

Mr. RIEHLMAN. One other quick question. An awful lot has been said here this morning in respect to the Nike-Zeus and its defense to the civilian population.

Do you have any comment you would like to make in respect to the need for a strong civil defense program for this Nation?

General MEDARIS. Well, I certainly feel that our people must achieve some realism in the area. By what means it is to be done, I don't know—but some way the consciousness must get across that the everyday citizen of this country must know how to behave and what to do under chaotic conditions.

It can probably best be achieved through a strong civil defense program, and passive defense measures are in themselves, also useful, but they do not solve the problems of our resources.

The CHAIRMAN. Mr. Quigley?

Mr. QUIGLEY. General, I want to join with those who have indicated that your testimony today has been the most provocative that has been presented to this committee as far as I am concerned in its entire history.

I would merely say that for myself, I think the country should thank God for parochial generals like yourself. [Laughter.]

If I could ask a question along the line of Mr. Riehlman's opening question: Is the Army itself, at this time giving any serious study or consideration to any other antimissile weapon other than the Nike-Zeus?

General MEDARIS. Not at this——

Mr. QUIGLEY. By "serious consideration" I mean funded studies and the like?

General MEDARIS. The Army, under its auspices, is funding with the authority of the Department of Defense and of ARPA, corollary studies in this research area looking to better means for defense against ballistic missiles, yes.

Mr. QUIGLEY. Are these related to Zeus or are they separated and above and beyond and entirely different approaches?

General MEDARIS. Some of them represent the exploration of possible different approaches. Some of them are intended merely to get more information about the characteristics of an incoming missile so that we may perhaps find other means for seeking it out. Some of them are related to possible future changes or refinements in the Zeus system, itself. They cover all those areas.

Mr. QUIGLEY. Do you think the Army is doing enough in this particular field of research——

General MEDARIS. The Army is doing all it has money to do and more, too. I think a little more could be done.

Mr. QUIGLEY. With more money?

General MEDARIS. That is correct, sir.

Mr. QUIGLEY. General, I gathered that your rebuff on the Nike-Zeus program is not the first time that you have had this experience in your career. I am thinking particularly that the space age arrived with us under a Soviet flag on October 4, 1957. Some 4 months later, thanks to you and the Von Braun team we finally got off the pad with Explorer I. As a matter of curiosity, how many months before October 4, 1957, could you have put a satellite in orbit?

General MEDARIS. About November 1956.

Mr. QUIGLEY. You could have?

General MEDARIS. Yes, sir.

Mr. QUIGLEY. Did you——

The CHAIRMAN. The gentleman's time has expired.

Mr. Wolf?

Mr. WOLF. I want to follow that, I didn't intend to, Mr. Chairman. But who was the man that was responsible for stopping that or was there a man or was it a system?

General MEDARIS. Well, this is, of course, the meat of the whole problem, because in the period of years that I have been involved with this system I have found that secretaries change and administrations change and the system seems to go on just the same. So I am somewhat disinclined to point fingers at individuals. But certainly we ran into every kind of frustration and denial in attempting to get a chance to do something in the space field, although we knew we had the capability. We got that authority finally when the Vanguard program, obviously, was unable to come through on the President's commitment to have a satellite in orbit during the Geophysical Year.

Mr. WOLF. I don't want to get into the political overtones of this, General, I think this is one of the unfortunate mistakes being made,

that this has taken on a political overtone. I said the other day and I will repeat it, I am the father of three children and like yourself I am concerned with the preservation of my country and the primary motivation that I know you have as well as myself and members of this committee. I would like to say if I may take a half minute of my time, General Schomburg, that we want to help you, we hope you will be frank with us and if you feel you have something down there that you can't give in open session, we could have a classified session and discuss it, because we have got to move ahead with this program and you are the boss now and we want to help you. I am sure I speak for every member of this committee.

General SCHOMBURG. Yes, sir.

Mr. WOLF. General Medaris, I would like to, if I can, put you in a position of—like, as you said, in the twilight zone group, I think it was, if you had an opportunity to do so, what changes might you make in the system of defense that we have, in the mechanics of operation of our Department of Defense.

General MEDARIS. Well, this is a very broad subject, Mr. Wolf, and I don't pretend to be such a broad authority that I could have at hand all the solutions. I do know that by some means the great administrative overload that now sits on top of the military services should be radically reduced, and I don't know any way to do it but with a meat ax. [Laughter.]

The concept of civilian control was successfully maintained for years and through a great world war, with a very small group of people appointed by and responsive to the Executive, only, and without the great assistance of the mass civil service employees that now seem to be required to assure that the military remain sufficiently dominated and sufficiently under control in detail. And I personally would take a broom right through the middle of that.

The CHAIRMAN. Mr. Karth?

Mr. KARTH. General, for a major portion of your statement at least I am of the opinion I am going to have to join the minority and the renegades along with you, because I think it is an excellent statement and gets to the heart of the problem that we face.

Mr. WOLF. Would the gentleman yield? I failed to mention that, Mr. Chairman, but I would like to join the minority, too.

Mr. KARTH. General, I would like to ask you that if the space program was under one head as you suggested, how much greater capability could we get out of the same dollar?

General MEDARIS. I think about 20 percent is my best estimate. This is a gross estimate, but my best intelligent estimate is about 20 percent.

Mr. KARTH. I would like, if you could General, to give the committee the benefit of your opinion on—I hesitate to call it system, but for lack of a better word I shall do so—it seems to me we put too much emphasis on sophistication, if the object is big, I mean, rather crude but it works we have to hold it in abeyance until we sophisticate it a little bit. Would you care to express your opinion on this thought?

General MEDARIS. This, of course, is the basic problem that got us into the fix that we are in in the first place. Now, the Russian, per se, not only has no fear of bigness or crudeness, but in fact, bigness has

been something the Russian seem to worship psychologically. He loves a great big thing, a monumental sort of creation. So they were not in the least deterred by the necessity for large size in getting into the long-range missile business as early as they did, and this caused them to come up with heavy powerplants.

We, on the other side, find ourselves in the position of having a certain worship for theoretical excellence, and we often rob ourselves of the margin that is necessary to give us reliability by insisting that we design down to the last half ounce. So that we wind up and we have done a very beautiful job. You could put it in a museum, but it is still much less effective than it would be if we had allowed ourselves a 10-percent margin or error and thereby had been able to come up with so-called crude solutions to some of these things. Sometimes the crude ones work the best, you know.

Mr. KARTH. Thank you.

One more question, Mr. Chairman: Could you very briefly give us your opinion of the feasibility of the man-in-space program upon which we are now embarked?

General MEDARIS. You are talking about Project Mercury?

Mr. KARTH. Yes, sir.

General MEDARIS. I think from a feasibility angle there is no question about it——

Mr. KARTH. Let me say from the possibility of success.

General MEDARIS. I think it will succeed. I think it is somewhat loosely organized and as a result it is going to take much longer than it ought to.

The CHAIRMAN. Mr. Hechler?

Mr. HECHLER. General Medaris, I have been sitting here with some fascination as these thunder bolts of yours have gone smoking by. [Laughter.] And there is one ingredient that seems to be missing here. I can't figure it out. I believe that many of the problems that our Nation is facing would be minimized if your statement and the ideas contained therein were seriously considered by the President of the United States and the National Security Council. What I would like to ask you is: Have you ever been asked by the President for your views? Have you ever had an opportunity to present these views to the President or have you ever had an opportunity to present them to the National Security Council?

General MEDARIS. I have never been asked for my views by any authority above the Secretary of the Army. I have been twice, I think, before the Security Council. Both times I had an assigned task; both times my statement had been most carefully examined.

Mr. HECHLER. What do you mean by that, "most carefully examined"?

General MEDARIS. Well, I think about five echelons must be satisfied with the wording and that it is only a statement of agreed fact and introduces no recommendations not theretofore adopted.

Mr. HECHLER. Would you go so far as to say it was censored, then?

General MEDARIS. I think this would be a fair statement, yes. But on the other hand, one must recognize that this is part of an organizational entity.

Mr. HECHLER. I must say, if I may interrupt at that point, General, that it seems to me that this is the most shocking revelation that has

ever been made before this committee. Something was said yesterday by the President in his news conference. The President said this—"The National Security Council in which nobody is barred from bringing up any fear or any matter any preoccupation on his mind, any anxiety or conviction, of course, we have to work by agenda but everybody there is just as free to express his opinion as a man can be."

General MEDARIS. I think he means everybody who is a member of the National Security Council, Mr. Hechler.

The CHAIRMAN. The gentleman's time has expired.

Mr. Daddario?

Mr. DADDARIO. General, you have been a strong supporter of the large multithrust engine for some time. Could you give us a little history of what your part in that has been? What you have done to obtain a larger engine or a cluster of them and what has happened to it?

General MEDARIS. Again, because of lacking a mission of sorts our official efforts in this direction could not be recorded as being very great.

However, we had considered and examined the engineering feasibilities quite some time ago.

We had examined means by which some pressure could be brought in some direction that would give consideration to the needs for larger engines and finally we did a trial balloon. Not exactly sure of my dates, but I think I can work it back: This was—let me see, it was 1957 that the Sputnik went up, and it was in the spring of that year that we came up with a request for authority to develop a somewhat larger engine than the one which is used as the basis for the Jupiter, the Thor, the Atlas, and Titan.

Now, this was a modest request because we could not base the request, officially, on anything having to do with space exploration. We based the request, then, on our desire to provide a certain margin of assurance, the same thing to which I was speaking a few minutes ago in this business of ultrasophistication, of trying to get enough margin of assurance in the IRBM program that we could be certain of having a completely dependable and reliable missile and not run into very marginal weight requirements that we couldn't see, and that sort of thing. We asked officially to be able to develop a motor of 200,000 pounds of thrust, which would have an ultimate capability of 250,000 pounds.

Now, in doing so, as I say, we had to predicate that request on its needs in connection with the only program we had, which was Jupiter. At the same time we did have in mind and in hand certain theoretical studies that would have permitted clustering such an engine, engineering studies I should say, in terms of four of them, which would have given a million pounds of thrust.

We didn't get very far. Finally, after we had asked a number of times about it, we got an answer from the Defense Department in terms of their appointing a committee.

The committee was known as the Silverstein committee and its purpose, its mission assigned, was to decide if there was any national requirement for a larger engine. Now, this was the summer of 1957. The committee report dashed all our hopes, because the Silverstein

committee report came up with the conclusion that in view of the trend toward smaller sizes in the atomic energy field, there was no conceivable future requirement for any engine larger than that then available. This was two months before Sputnik.

Mr. DADDARIO. That was the Silverstein committee, and Mr. Silverstein is now with the National Aeronautics and Space Administration which has as its responsibility the development of such an engine?

General MEDARIS. That is true, Mr. Daddario.

Mr. DADDARIO. And it has been agreed that this is a large national requirement?

General MEDARIS. That is correct.

The CHAIRMAN. The gentleman's time has expired.

Mr. King?

Mr. WOLF. If the gentleman would yield, that is pretty much like putting a fox in the chickenhouse to guard the chickens; isn't it?

Mr. KING. General, in support of the argument in favor of the Von Braun team to NASA, it has been reasoned the basic responsibility of the Defense Department, of course, is defense. It would be unfair, therefore, to distract them or to get them off into a large operation only a part of which was concerned with defense and an even larger part of which was concerned with purely peaceful occupations, and so on. You understand the argument. I would like to get your reaction to that because that argument, I must admit, had some effectiveness and persuasiveness on me.

General MEDARIS. I must go back here, Mr. King, to the indivisibility of the field as such and to the fact that it reinforces itself. In dividing it you come up with a solution that is in fact harder overall to handle. I think even as far as the operating individuals in the Defense Department, the services themselves, are concerned, that they would find it easier to handle as a package than they do to handle only their part of it. We now have a situation where for weapons purposes as they may come up, either the Defense Department must depend upon NASA to develop the vehicle and buy the vehicle from NASA, or vice versa, NASA must depend upon the Defense Department to develop a vehicle for them and buy it from the Defense Department, or alternatively we have duplicating programs, one of the three. This adds enough clumsiness in my mind to far more than offset this requirement that the military not be concerned with this area. Furthermore, I think that military uses will develop out of peaceful exploration and peaceful facts, as they always have in the past. The argument appears to be a little strained since I find nobody rising to meet the urgency of getting the military elements of the Army, to wit: The Engineer Corps, out of the rivers and harbors business. If it is good one place why isn't it good somewhere else? What is the difference?

Mr. KING. It was the Army that constructed the Panama Canal, as I recall.

General MEDARIS. I think so, and opened the West.

Mr. KING. Do you think—perhaps there is time to just touch this—that where there are two commands instead of one that there is always the difficulty of exchanging information so that the one command isn't certain of what the other command has found out?

General MEDARIS. This is a very awkward situation and with the best will on everybody's part—this is not a question of withholding information—but the pure mechanics of the lateral exchange of detail on everything that is going on between organizations not under single control is a very formidable task, and it cannot be done within normal human resources to the degree of completeness that is essential to assure taking full advantage of everything that is learned.

The CHAIRMAN. Mr. Roush?

Mr. ROUSH. General, I have a series of short questions which I hope will require short answers.

General MEDARIS. I will do my best.

Mr. ROUSH. Prior to October 4, 1957, was the Army ever under any positive instruction not to tinker with this orbital business?

General MEDARIS. It certainly was.

Mr. ROUSH. Is it true that the Army initiated Project Saturn?

General MEDARIS. That is true.

Mr. ROUSH. And is it also true that funds were requested from ARPA which were denied for Project Saturn?

General MEDARIS. Funds were requested in greater quantity than ARPA made available.

Mr. ROUSH. All right. Is it true that as late as the last part of 1959 funds apportioned for Saturn were cut back?

General MEDARIS. That is correct.

Mr. ROUSH. If you had been allowed to go ahead with your large engine back in 1957 and would have had the funds, would we have an engine today with a million-pound thrust capacity?

General MEDARIS. If this had been a coherent program and the objective had been so stated, we would be very close to it. We would probably be in a position to fly such a vehicle within the next 6 months, I would say.

Mr. ROUSH. Do we have a present military requirement for a large booster engine?

General MEDARIS. Well, here we come back to the question of what is the military requirement in space. Again, I say that in my opinion there will be a very positive military requirement in space, in fact such exists right now in the classified military programs. So they either have to use Saturn or develop another one for that requirement.

Mr. ROUSH. You spoke of projects you would like to see cut out. Which projects which we now have under consideration would you like to see enhanced and furthered and pushed?

General MEDARIS. I think fundamentally in the space area we must look to the Saturn. And certainly Nike-Zeus in the defense area is the most important one that we have. In the strategic strike capabilities I look to Polaris as the most effective weapon.

Mr. ROUSH. Is it true that——

General MEDARIS. And—well, certainly I would like to add that the Saturn is merely a means to an end. The man in space program, a man on the Moon program must be pushed forward.

Mr. MCDONOUGH. That is very important.

General MEDARIS. Mercury then is important as the bridge to it.

Mr. ROUSH. Is it true that because of all of these administrative difficulties and this bureaucracy in which we are living that it is diffi-

cult for us to have a positive decision which will carry us to a certain end?

General MEDARIS. I can only say that anytime in the last 5 years that I have gotten a decision that lasted more than 6 months I was ahead.

Mr. ROUSH. I heard you say once, General, that the one thing that would put us back into this race with Russia was the ability to make a decision and then stick with that decision for at least 2 years. Do you still adhere to that?

General MEDARIS. I still adhere to that.

The CHAIRMAN. The gentleman's time has expired.

Mr. BASS. Could I have one question?

The CHAIRMAN. Mr. Chenoweth asked for one question; Mr. Bass asked for a question. Everybody has had the same identical time now. Nobody can complain.

Mr. CHENOWETH. Mine is not a question. I would like to have 15 seconds.

The CHAIRMAN. The gentleman asked for 15 seconds.

Mr. CHENOWETH. General, I wonder if you have in your pocket a little poem entitled "Medaris, Von Braun and Me"?

General MEDARIS. Unfortunately, I haven't, I am sorry. I wish I had. I would like to get that in the record, however, if I may. If I may have the opportunity I will extend the record with it, yes, sir.

Mr. CHENOWETH. Would you please?

(The poem is as follows:)

THE RELUCTANT ASTRONAUT

In the missile game we've won great fame.
The world knows our Jupiter C—
And what we've done with Explorer I,
Medaris, Von Braun, and me!

Explorer III went off in the blue
On its own self-guided spree.
Number III kept in track and now reports back
To Medaris, Von Braun, and me.

We will send others to join their brothers.
Some will orbit, some fall in the sea.
Yet history will toast the man with the most:
Medaris, Von Braun, and me.

Oh, watch our smoke as we go for broke,
To solve the space mystery.
We have a thirst to be there first,
Medaris, Von Braun, and me.

Our skill we pride. We'll travel wide
Into spaces so wild and free—
To the Moon, then to Mars, then to distant stars,
Medaris, Von Braun, and me.

When finally we've planned a spaceship that's manned,
And they call for brave men—two or three—
To try first for the Moon in that metal balloon,
Call Medaris and Von Braun. Not me.

—*Ivan E. Hirshburg* (ABMA, 1958).

The CHAIRMAN. Mr. Bass?

Mr. BASS. You indicated earlier that there is a present military requirement for the big booster engine. What is that military requirement?

General MEDARIS. That has to do with the Dyna-Soar program.

The CHAIRMAN. General, we want to thank you and General Schomburg, too. We haven't given him so many questions there but we have gotten a great deal of help out of General Medaris and General Schomburg, and we appreciate the opportunity of having you here as witnesses.

Gentlemen, the subcommittees begin to meet at 2 o'clock on the NASA authorization program and I think you two have given these subcommittees a lot of motive power, a lot of enthusiasm to carry on with the program.

We will adjourn.

Mr. QUIGLEY. Would you ask the members of the patent subcommittee to stay over about two seconds?

The CHAIRMAN. The members of the patent subcommittee are requested to stay over here about two seconds to get a report.

Now, we are giving the subcommittees a chance to begin at 2 o'clock and we have no session in the morning—the full committee.

(Whereupon, at 12:01 p.m., the committee adjourned to reconvene at the call of the chairman.)

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